Tech Tonic

Towards a New Literacy of Technology

Alliance for Childhood

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The Alliance for Childhood is a nonprofit partnership of educators, health professionals, researchers, and other advocates for children. The Alliance promotes policies and practices that support children's healthy development, love of learning, and joy in living.

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Alliance for Childhood Roundtable on Rethinking Technology Literacy

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Contents

Dedicated to the memory of
Fred Rogers and Neil Postman, two champions of childhood and children.

Overview

Preparing Children for a New Century

The three central arguments of this report:

1. *Our children face a daunting technological frontier of irreversible changes in human biology and the world's ecology. They need a radically different kind of technology education to make wise choices in such a future.*
2. *Children's lives are increasingly filled with screen time rather than real time with nature, caring adults, the arts, and hands-on work and play. Yet only real relationships, not virtual ones, will inspire and prepare them to protect the Earth and all that lives on it.*
3. *There is scant evidence of long-term benefits—and growing indications of harm—from the high-tech life style and education aggressively promoted by government and business. It is time for concerted citizen action to reclaim childhood for children.*

Today's children live vastly different lives in relation to advanced technologies than children did even 25 years ago. Personal computers were then just coming on the market and had not appeared in schools. The internet was available only to scientists. Laptops, cell phones, and hand-held electronic devices were things of the future. All of these—as well as the ubiquitous television screen—are now considered necessities by many families and schools.[1]

The supposed benefits of this techno-revolution for children are relentlessly promoted by high-tech corporations, even though independent research (conducted by those with no financial stake in the outcome) has produced little evidence of lasting, long-term gains. At the same time, the damage being done by immersing children in electronic technologies is becoming clearer. Increasing numbers of them spend hours each day sitting in front of screens instead of playing outdoors, reading, and getting much-needed physical exercise and face-to-face social interaction—all of which, it turns out, also provide essential stimulation to the growing mind and intellect.[2]

In September 2000 the Alliance for Childhood published *Fool's Gold: A Critical Look at Computers in Childhood* and issued a call for action, endorsed by dozens of leading educators, health professionals, researchers, technology experts, and other advocates for children. The group called for a moratorium on the further introduction of computers in early childhood and elementary education, a new emphasis on ethics, responsibility, and critical thinking in technology education for older students, and a broad public dialogue on how computers affect the real needs of children.

The Alliance's actions ignited a storm of news stories and public debate on questions that previously had barely registered on media radar: Do children really learn better with computers than without them? Do the gains found by some short-term studies of children's use of technology persist in the long term? Has research on the effects of children's use of computers been compromised by the influence of corporate funding? Is the increasing use by children of electronic technologies actually undermining their health and well-being?

One of the first phone calls the Alliance received after *Fool's Gold* appeared was from a father in despair. The previous spring he had bought his family a computer, thinking this would be of help to his school-age children. Over the summer he had not been able to get his children outside to play; they were too mesmerized by all the things the computer could do. What, he wondered, about all the things his children would normally have done that summer? What about the bikes unridden, the trees unclimbed, the conversations not held—even the arguments with friends that are part of growing up? For this father, the losses were great and the gains seemed paltry.

Though some critics reacted angrily to *Fool's Gold* and the Alliance's call for action, the general public response was surprisingly positive. In an online poll conducted by MSNBC, 53 percent of the 3,090 respondents (all of whom were necessarily computer-savvy) agreed with the Alliance's call for a moratorium and that the benefits of computers for children had been exaggerated. An online poll on CNN's web site produced similar results. In addition, a number of engineers and scientists reported their growing concern about the lack of creativity and hands-on skills they saw in their younger colleagues who had grown up using computers.

Four years later, the reasons for reassessing the impact of the new high-tech life style on children are even more urgent. Childhood obesity has become a major health issue; anything that contributes to a sedentary life should be examined to see if its benefits outweigh the risks. Though the bursting of the dot-com bubble slowed down the technology hype for a time, the underlying assumptions among education policymakers and many parents about technology's value have not changed.

We remain convinced that, at the elementary school level and below, there is little evidence of lasting gains and much evidence of harm from the hours spent in front of screens. For us, the decision is an easy one: de-emphasize high-tech products and let children thrive and grow. There's plenty of time in adolescence for children to learn, with adult guidance and reasonable limits, to navigate the complex world of advanced electronic technologies.

Research strongly indicates that face-to-face relationships with people and the rest of the natural world are critical not just for young children but for older students as well. Middle school, for example, is the time when most students are ready to tackle the kinds of research for which access to the tremendous resources of the internet would be useful. But well-equipped school or community libraries can provide that access without the expenditure of limited educational dollars required for outfitting every classroom with the latest equipment or giving laptops to every child. This would also give librarians and teachers a chance to collab-

orate in introducing both the relatively easy-to-learn technical skills needed for online research and the far more challenging issues of ethics and critical thinking.[3]

At the high school level, it makes sense to offer students opportunities to master a range of high-tech skills. But again, the greater challenge will be preparing them for the personal and social responsibilities that powerful new technologies pose. In this report, the Alliance for Childhood takes up that challenge. We lay out the arguments, principles, and guidelines for a healthier, more humane, and more responsible approach to fostering a real technology literacy that prepares children for the future while meeting their developmental needs today.

A Call for Dialogue and Assessment

Technological creativity is a natural part of life. All of nature is active in building and even innovating to meet changing needs. Bees build hives, beavers build dams, birds build complex nests—but they do so mainly out of instinctive knowledge. They adapt to a changing environment, but do so quite slowly. Human beings, on the other hand, are marvelously able to adapt, innovate, and create. They try out one thing and discard it for another at a remarkable evolutionary pace.

A more cautious approach to innovation has been developed in medicine, which has long been guided by the principle "First, do no harm." New medicines must prove their efficacy and relative safety before being allowed on the market. Even so, long-term harmful effects are sometimes discovered and medicines must be pulled off the shelves completely or used in a more limited way. Imagine the immense harm if there were no regulations on the uses of powerful drugs, and if there were no objective studies of their long-term effects.

Yet that is exactly the situation today with the use of powerful new technologies by children. There is no assessment of relative usefulness versus harm when a new product is introduced for school or home use. To suggest that one is necessary is to invite accusations of being "anti-technology."

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Our purpose here is to spark a much-needed dialogue. How does immersion in high-tech products and the related reduction in face-to-face experiences with people and the rest of the living world affect children physically, emotionally, socially, mentally, and spiritually? We know that emotionally engaging encounters with the real, living world enrich childhood and sustain each generation's commitment to life itself. Never has such a commitment been so vital for humanity's social and ecological prognosis than in these early years of the 21st century. To the extent that we allow children to be distracted by "virtual" realities, both childhood and our democracy will be impoverished.

Preparing Children for a Daunting Future

We have titled this report "Tech Tonic" both because we believe that current approaches to technology education are unhealthy and in need of a curative dose of common sense, and because the remedies we call for are not superficial but deep and structural. They require a fundamental, tectonic change in our underlying assumptions and beliefs about children's development and the practices that are most supportive of healthy growth.

How do we prepare today's children to make wise decisions about tomorrow's technologies? It is certain that they will be faced with moral and ethi-

cal questions about the development and use of technology that no society has ever faced before. Is the cloning of humans and other species morally defensible, and, if so, when? How much responsibility for decision-making should we turn over to artificial intelligence machines? To what extent is virtual reality an adequate substitute for a disappearing natural environment? Do certain high-tech innovations lend themselves to such uncontrollable and destructive uses by terrorists, rogue nations, or even irresponsible individuals that the dangers justify their prohibition? How might such prohibitions be enforced?

How today's children and youth respond to these questions will, in great part, be determined by the education we provide them. The success of that education, in turn, will depend on helping our children develop the capacity to wrestle with even more fundamental questions—questions that, until now, seemed utterly abstract: What does it mean to think? What is real? What is natural and what is artificial? What does it mean to be alive? What does it mean to be human?

As citizens in a democracy, we all share moral responsibility for our technological future. What shall it be? The daunting possibilities of our own technological creativity now challenge us to take up this question with the ethical awareness and social commitment that it demands.

When it comes to the deeper education of our children, we often take the easy way out. We thrust computers into the hands of infants and toddlers and think that making them comfortable with hardware and software will prepare them for the future. It will not. Current approaches to technology education, mostly focused on training children to use machines, are inadequate. What children need, instead, is an education that prepares them, as citizens, to help solve our most pressing social and ecological problems. They need an education, moreover, that helps them understand that technical skills alone cannot solve those problems. The active social engagement and moral commitment of human beings representing diverse voices and cultures will always be necessary.

Because fundamental questions of biology and ecology may soon be subject to human control—control by our children—they can no longer be left for philosophers in ivory towers to ponder. Nor can they be left to scientists and technicians experimenting in laboratories, CEOs in boardrooms, or politicians responding to special interests. They should be addressed in coffee shops, town halls, pulpits, the press, and, of course, the voting booth. But they must also be addressed in our homes and in our schools. Questions about the ethical design and use of technologies need to become as fundamental to our community and political life as are issues about the economy and the environment.

Principles and Actions

In this document the Alliance for Childhood proposes a new definition of technology literacy: The mature capacity to participate creatively, critically, and responsibly in making technological choices that serve democracy, ecological sustainability, and a just society.

We offer ten principles for developing this new technology literacy, and a six-point agenda for action by parents and citizens.

In Chapter 1 we go into the deeper nature of our technological creativity and the unprecedented moral challenges it now poses. In Chapter 2 we look at the unintended lessons of today's high-tech childhood. In Chapter 3 we examine the most commonly used standards for technology education and the role of the school-technology vendors in promoting those standards. We come to the heart of our recommendations in Chapter 4, our ten principles for developing a new and more socially conscious technology literacy:

1. Slow down: honor the developmental needs of children.

2. With adolescents, teach technology as social ethics in action, with technical skills in a supporting role.
3. Relationships with the real world come first.
4. Technology is not destiny; its design and use flow from human choices.
5. Choice implies limits—and the option to say "no."
6. Those affected by technological choices deserve a voice in making them.
7. Use tools and technologies with mindfulness.
8. To teach technology literacy, become technologically literate.
9. Honor the precautionary principle: When uncertain, err on the side of caution.
   - Ask tough questions about long-term consequences.
   - Make time, space, and silence for reflection.
   - Responsibility grows from humility.
   - Be resourceful with the tools you already have.
10. Respect the sacredness of life in all its diversity.

In Chapter 5 we give concrete examples of educational programs that illustrate these ten principles in action. In Chapter 6 we look at the complex question of child development, the real essentials of a healthy childhood, and the ways to assess what kinds of technology children need and when they need them.[4] In Chapters 7 and 8 we offer ideas for citizens and educators on how to develop their own personal technology literacy in its deepest sense, so they are better prepared to guide children in making responsible technological choices. In Chapter 9 we address some commonly asked questions about children and technology.

Finally, we call on parents, educators, and policymakers to make seven key reforms to foster a new approach to technology literacy:

1. Make human relationships and a commitment to strong communities a top priority at home and at school.
2. Color childhood green to refocus education on children's relationships with the rest of the living world.
3. Foster creativity every day, with time for the arts and play.
4. Put community-based research and action at the heart of the science and technology curriculum.
5. Declare one day a week an electronic entertainment–free zone.
6. End marketing aimed at children.
7. Shift spending from unproven high-tech products in the classroom to children's unmet basic needs.

If this report simply opens the doors to further questions and debate, we will be satisfied. But we hope it will do more than that—we hope it will lead families, educators, and community groups into deep conversation and action. Our greatest hope is that it will inspire much-needed changes in the way we raise and educate our children. A healthy, active childhood is the tonic they need to grow into compassionate, thoughtful, courageous, and resourceful adults—willing and able participants in the daunting choices that lie ahead.

References

1 A 2000 survey of 1,235 parents of children between the ages of 2 and 17 found that 57 percent of children ages 8 to 16 had televisions in their bedrooms (36 percent with cable service), 39 percent had video game equipment, 30 percent had a VCR, and 20 percent had a computer. These numbers are now undoubtedly higher. See Emory H. Woodard IV, with Natalia Gridina, "Media in the Home 2000: The Fifth Annual Survey of Parents and Children," Annenberg Public Policy Center of the University of Pennsylvania, 2000, p. 3.

2 Children ages 2 to 17 in the Annenberg study cited above were reported by parents to spend, on average, more than four and a half hours (281 minutes) at home in front of screens each day. That included watching TV or videotapes, playing video games, and using computers. Woodard, op. cit., p. 19.

3 For example, basic lessons in plagiarism seem to be lost in the haste to teach students to use the internet; as a result, plagiarism is a growing problem in schools.

4 Chapters 5 and 6 will be supplemented by additional material available on the Alliance web site (www.allianceforchildhood.org) with specific suggestions for different age groups.

Chapter 1

Reclaiming Technology: Why We Need a New Definition of Technology Literacy

In the past, technology literacy was largely defined as skills in operating computers. That narrow approach was misguided from the start. But it's now dangerously outdated. A new approach to technology literacy, calibrated for the 21st century, requires us to help children develop the habits of mind, heart, and action that can, over time, mature into adult capacities for moral reflection, ethical restraint, and compassionate service.

Technology as Social Ethics in Action

Our children are growing up on the most sobering technological frontier in history. They inherit a complex set of global dilemmas, and the stakes are clearly ones of life and death writ in large numbers.

The challenges include global warming; the proliferation of weapons of mass destruction; the unprecedented die-off of forests, fish, birds, and other species; the depletion of soils; and the challenge of providing enough food and fresh water to the largest human population Earth has ever supported. Moreover, aggressive efforts by governments and industries around the world to accelerate technical advances in genetic engineering, robotics, and nanotechnology have led Bill Joy, co-founder and former chief scientist of Sun Microsystems, to warn that their convergence could pose toxic, self-replicating technologies that could lead to "self-inflicted extinction" in the next few decades.[1]

"Will we survive our technologies?" asks Joy. "We are opening Pandora's box, yet people have barely begun to notice. We are designing technologies that might literally consume ecosystems."[2]

The complexity and connectedness of the technological infrastructure we are so dependent upon—for everything from electricity to banking services—also have made us acutely vulnerable to sabotage, whether from terrorists, rogue nations, or precocious teen-age hackers.[3]

How can we help our children develop the wisdom, compassion, courage, and creative energy they will need to face this technological frontier in ways that sustain rather than endanger life? The answer, we propose, is a thoughtful new approach to teaching children about their technological heritage—one that is firmly rooted in the study and practice of technology as social ethics in action and in a renewed respect for nature as the ultimate source and setting for all our technologies.

We call for education that prepares children to participate in discussions and decisions about how technologies can serve democracy, a fair and equitable social order, and ecological sustainability. Equally important, we call for education that emphasizes creativity, imagination, artistry, and the strengthening of the child's inner resources rather than dependence on machines and pre-digested images and scripts. For it is only through truly imaginative thinking that our children will be able to devise solutions—both high- and low-tech—to the global crises they will face.

In the past, technology literacy was largely defined as skill in operating computers. That narrow approach was misguided from the start. But it is now dangerously outdated. A new approach to technology literacy, calibrated for the 21st century, requires us to help children develop the habits of mind, heart, and action that can, over time, mature into adult capacities for moral reflection, ethical restraint, and compassionate service.

This means re-emphasizing relationships—with people and with nature—and curtailing the barrage of commercial messages aimed at children, which so often discourage reflection, restraint, and consideration of others. It means rethinking the wisdom of allowing children to spend so much time being passively entertained by electronic devices. It means reviving the arts, child-initiated play, and hands-on experiences of all kinds as crucial precursors to the energetic technological, social, and ecological creativity our children must exercise to survive this new century.

And it means providing adult guidance and mentoring in gradually introducing children to the full range of technologies in developmentally appropriate ways. Key to the last is nurturing in children, and in ourselves, a healthy new skepticism in evaluating potential technological change. Our children will not have the luxury of choosing powerful new technologies solely on the basis of their speed, power, or convenience. With the stakes so high, they will need also to scrutinize the possible long-term consequences of their widespread use.

Rerooting Technology in Nature

The kind of critical thinking we call for is by no means anti-science or anti-technology. On the contrary, we celebrate the awesome gift of our species' technological creativity as essential to our children's human inheritance. But we also wish to reclaim for them the rest of their technological inheritance: the long history of societies and cultures that honored technology as a double-edged sword, to be handled with care. In rituals and myths, like the Greek tale of Daedalus and Icarus,[4] people around the globe have passed on to each new generation the importance of treating this powerful gift with respect and restraint.

They taught their children that technological genius is rooted in nature. Nature was understood to be a vast source of life and death, and of technologies themselves. Young people experienced for themselves how dependent human technologies are on natural forces and materials to help us feed, clothe, and shelter our families and create meaning in our lives. Whether it was fire for forges and river water for irrigating crops, the hair and sinews of

animals for thread and rope, or the burning of sage or wild parsnips for purification rites, humanity's reliance on the gifts of the natural world was obvious.

Elders also taught children the practical wisdom of balancing technological power with gratitude, humility, generosity, and reciprocity towards the rest of the natural world. Children learned that it is good to receive the life-giving gifts of the plant, animal, and mineral worlds and to reshape them for human purposes. But in many cultures they also learned that it is wise to observe reasonable limits and to offer some gift or sign of respect in return.[5] Children learned that all things—including human technologies—were alive, woven into one sacred web of life.

Ancient and traditional technologies like hunting, gathering, fishing, farming, making clothing and shelters, firing pottery, mining, smelting, metalworking, and combat often had their own special rituals, ceremonies, taboos, and myths. Sometimes arduous initiations were required to learn and practice these skills.[6] So children also absorbed lessons about the care and respect that making and using tools requires.

Children learned, in other words, that the design and use of technologies are charged with moral meaning. It would be naïve to ignore the evidence that human cultures in the past, as now, acted at times in ways that caused severe ecological damage, including destroying forests, depleting soils through intensive farming and irrigation, or driving species to extinction through overhunting and the destruction of habitat. But the traditions themselves indicate a sensitivity to avoiding such catastrophes, a willingness to learn practical lessons about limits from nature, and a realistic sense that ultimately human beings need to fit their technologies within nature, rather than against nature, for our own long-term survival. This practical wisdom is a lesson for parents and educators today, as we introduce our own children to the moral responsibilities of our culture's unprecedented technological prowess.[7]

The natural world remains the primary source, and, as we noted above, the ultimate setting within which technologies must fit. Because the unintended consequences of our technologies sometimes cancel or overwhelm their intended purposes, there is good reason to teach our children respect and restraint.

Thinking Ahead

Much has changed for children in the course of just one generation. Even very young children are now often left largely alone to operate advanced electronic devices like computers. Some busy adults happily turn over to them the task of programming the VCR, the cell phone, or the computer. The sense of competence and autonomy that many young people find in this new role has undeniable benefits—but it can also create new dangers. Many parents and teachers report an initial enthusiasm about children's use of computers followed by a growing concern about children's overuse and even addiction to the technology. We cannot expect children to exercise wisdom in the use of technology. They do not know where the boundaries are, nor the pitfalls. Rather, they count on us for that wisdom. Are we meeting their needs?

The Haudenosaunee Confederation, or League of the Iroquois, practiced thinking ahead. They began every council meeting with an invocation to the "Seven Generations": "For each decision made or action taken, consider the effects on those who will live in the seventh generation from now." What if we had invoked that principle in the development of automobiles? Would we have made different choices if we had envisioned global warming and pollution or a world highly dependent on oil? Might we have developed alternative fuels and technologies more quickly and energetically?

The new approach to technology literacy we propose in these pages is inspired by that spirit of

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mindfulness, empathy, and democratic action. Our children could then bequeath to their children a new generation of tools—tools focused less on consuming and controlling and more on sustaining and serving.

Thinking ahead does not mean preventing the development of new technologies. It does mean moving a little slower, with a commitment to informed public discourse and to the development of substantial new opportunities for broad participation in technological choices. It means valuing sustainability—which is nothing more than providing a healthy, living world for our grandchildren's grandchildren's grandchildren.

Inherent in such a review is an emerging ethic based on the recognition that technologies have a way of "biting back," in the words of Edward Tenner.[8] The histories of the use of asbestos, DDT, nuclear energy, chlorofluorocarbons, and leaded gasoline and paint were all marked by initial enthusiasm, belated reflection on the consequences, and finally agreements to limit or, in some cases, abandon their use. This history of what Howard Segal points to as technology's "mixed blessings"[9] should be explicitly taught to older students.

Political historian Francis Fukuyama, in *Our Posthuman Future*, predicts that the implantation of microchips will create opportunities to "enhance" human beings and change the very nature of being human. Modern democracies, he points out, have been created to serve human beings as we are. What new social form will emerge to serve the "enhanced" human being? he asks.[10]

Likewise, what will be the effects on the natural world of altering the genetic makeup of plants, animals, and humans in ways that we don't yet understand but which we will most likely not be able to reverse in the future? The potential harm of today's emerging technologies is considerably more subtle than the overt destruction of an atomic bomb, but may have an equally devastating impact.

How can we prepare our children to participate in the tough technological choices looming before them? If we teach them only a blind enthusiasm for technology, how will they learn to think and act creatively and critically?

Developing a New Technology Literacy

The Alliance for Childhood calls for a new approach to technology literacy, based on two fundamental concerns. First, we must approach our capacity to develop and use powerful new technologies with restraint and respect—a respect that takes into account its potential for enormous material, social, and ecological repercussions, both positive and negative. This will require educating ourselves and our children about our technological heritage, including the full range of effects of individual technologies and the complex interplay of technological systems.

Second, we must give our children and youth the full opportunity to get to know themselves through play, the arts, and hands-on learning, so that they have a solid sense of self—and confidence in their own creativity and competence—before tackling the major issues of the world. We must recognize the essential need of children to engage in real relationships with human beings and with nature while they are young. They need this for their own growth and development, and in order later to make wise and compassionate decisions

about powerful technologies that will affect human, plant, and animal life. What kinds of decisions will they make later if they have not learned when young to love living things?

Technology education is not the only field where a new way of thinking is gradually emerging. Physicist David Finkelstein of the Georgia Institute of Technology describes the development of new thinking in physics in terms that can be applied to technology literacy as well:

> I used to think of 1924, the year in which Heisenberg discovered the quantum theory, as a kind of abyss, a Grand Canyon, separating the old physics from the new, or a desert separating two fertile regions. But this is too symmetric. The two sides of an abyss are on the same level. The two sides of a desert are symmetric in respect to each other. Really we should regard this as a change in level, an evolutionary step: Quantum theory is on a higher plateau than the older physics. Those on the lower plateau find the upper one invisible, mysterious and confusing. When you reach the upper plateau, you see the lower one and recognize it as a part of a much larger picture.[11]

We propose a similar shift to a higher level of thinking in the education of children in general and about technology in particular. It is not a simple step but one that requires us to see the world anew and to turn ourselves inside out to rediscover the seeds of being human.

"We are learning the fundamental principle that ethics is everything," writes biologist Edward O. Wilson in his 1999 book *Consilience*.[12]

> No one wished it so, but we are the first species to become a geophysical force, altering Earth's climate, a role previously reserved for tectonics, sun flares, and glacial cycles. We are also the greatest destroyer of life since the ten-kilometer-wide meteorite that landed near Yucuta'n and ended the Age of Reptiles 65 million years ago. Through overpopulation we have put ourselves in danger of running out of food and water. So a very Faustian choice is upon us: whether to accept our corrosive and risky behavior as the unavoidable price of population and economic growth, or to take stock of ourselves and search for a new environmental ethic.[13]

Children will be well served by a renewal of science and technology education that explicitly brings issues of meaning and value—including the value of what the physicist David Bohm called "genuine love"—back to the study and crafting of matter. "If we can obtain an intuitive and imaginative feeling of the whole world, as constituting an implicate order that is also enfolded in us, we will sense ourselves to be one with this world," Bohm said. "We will no longer be satisfied merely to manipulate it technically to our supposed advantage, but we will feel genuine love for it. We will want to care for it, as we would for anyone who is close to us."[14]

The practical power of this approach is demonstrated by the impact of Rachel Carson's work. She was inspired by her passion for nature to attend to evidence that others had failed to notice—the consequences of the indiscriminate use of pesticides—and then to meticulously document those effects in her 1962 book *Silent Spring*. As biochemist Linda Jean Shepherd notes, Carson was attacked as a "cat lover," a "fish lover," and a "bird lover." Those charges were true, of course, and her love of nature became the source of her scientific insight and persistence.[15]

For real technology literacy, we should focus on educating our children, at home and school, in ways that help them cultivate a profound sense of the goodness of life and of their own capacity to respond from the goodness of their own humanity. As biologist Stephen Jay Gould suggested, "We cannot win this battle to save species and environments without forging an emotional bond between ourselves and nature as well—for we will not fight to save what we do not love."[16]

Technology Education for Democracy

We need a new sense of technology not just as tools of convenience, entertainment, profits, and power but as a form of social ethics with opportunities for voices at every level of society to be heard and heeded.

That means preparing and encouraging children to be actively engaged in these issues. Commercial pressures on individuals and competitive pressures on businesses to adopt new high-tech products have fed a broad cultural assumption of technological determinism—that technologies forge ahead under their own steam, independent of human influence. For adolescents, the pressures can be especially intense. The sales pitches and power associated with some contemporary electronic technologies often tap into their natural interest in gaining autonomy from adults as well as their need to fit in socially with peers. Marketing that tags particular products as "cool" encourages them to assume that newer, faster, and more powerful automatically means better.

But as Richard Sclove argues in *Democracy and Technology*, technologies "do not just appear or happen." They are based on explicit or tacit social choices. And just as technologies stem from social choices that have ethical repercussions, they often have significant social and moral consequences far beyond their immediate intended function.

"Recognizing the many respects in which technologies contribute to defining who people are," Sclove writes, "what they can and cannot do, and how they understand themselves and their world should dispel the common myth that technologies are morally or politically neutral."[17]

Older students deserve thoughtful exposure to our technological history and encouragement to assess its lessons critically. We can help them consider, for example, the many examples of both sacred uses and thoughtless abuses of the technological power of our species. And we can help them to think about the future in terms of the challenges of identifying our most pressing social and ecological problems, and then redirecting science and technological development to meet those needs.

Real technology literacy places at least as high a priority on this kind of social creativity as it does on scientific and technical creativity. If we are to attend to those pressing problems we need technologies and technological systems that are "of the people, for the people, and by the people." To teach children to value and to practice such community-oriented action, we should put the quality of human relationships at home and school at the top of our educational priorities. That means shifting resources from technological fixes, such as the current emphasis on computers and standardized tests, to developing schools as vibrant social communities where the contribution and voice of each individual is invited and valued.

We must also revive child-initiated play. Research demonstrates that time spent in play—especially social "let's pretend" play—is related to children's ability to solve problems creatively through divergent thinking. That is the kind of flexible thinking that considers many possible right answers instead of just one. It is essential for solving problems for which there is no one easy answer.

Addressing those complexities successfully will hinge, in part, on the ability of our children to consider questions from several points of view and to devise creative solutions that attend to the needs of all sides. Without that ability, citizens may prefer to pass on such tough decisions and let authoritarian governments or centralized corporate offices shape the future for them.

Seven Key Reforms for a New Literacy of Technology

How do we, as parents, educators, and citizens, begin to foster this new way of thinking that embraces ethics, mindfulness, and restraint? It will

not be easy in a culture that tells us constantly that children need every advantage—often interpreted as the latest high-tech product—in the race to come out ahead of their peers. We will argue, in this report, that a true understanding of children's capacities, needs, and vulnerability will lead to a "slow knowledge"[18] approach to technology education that, in the end, will be much more powerful and effective than has been the headlong rush to have third-graders produce PowerPoint presentations .

Education must nourish children from the tops of their heads to the bottoms of their feet. We are not interested in education that speaks only to the fingertips or addresses the brain as if it lives in a box separate from the whole body. Education, about technology or anything else, should address the whole child and integrate thoughts, feelings, and actions.

In subsequent chapters we offer specific guidelines and examples for educating children about technology in ways that are developmentally appropriate at different ages. But we recommend the following seven key reforms for all ages:

1. **Make human relationships and a commitment to strong communities a top priority at home and at school.**

Every major change in how we approach childhood should be evaluated for its effect on relationships within families and schools. Proven educational reforms, for example, include smaller class size and involving parents and other members of the community in the life of a school. Make sure that every child, from preschool through high school, has at least one adult on the premises who knows the child's strengths and challenges and who takes personal responsibility for nurturing that child's long-term well-being and happiness. The latter may be the single most cost-effective reform possible, if we are serious about leaving no child behind.

2. **Color childhood green to emphasize children's relationships with the rest of the living world.**

At the neighborhood level, this means advocating for green spaces for children to play and explore outdoors. If safety is a concern, organize with other concerned adults to monitor play areas. It's also time to strive for "green" schools for every child. As the Center for Environmental Education at the Antioch New England Institute has pointed out, schools can and should be "miniature models of a sustainable society," to prepare children to take up the ecological challenges of the future with competence and enthusiasm.

Schools should bring nature into the curriculum, from science and math to the arts and humanities. School gardens combined with cooking and nutrition lessons, farm-to-school lunch programs that promote relationships with local farmers, more naturally landscaped playgrounds, native-plant cultivation, and camping trips are all options, as are rooftop gardens, butterfly gardens, ponds, and place-specific projects, such as far-north gardens, desert gardens, or prairie restoration.[19]

3. **Foster creativity every day, with time for the arts and play.**

Encourage creativity and imagination by making time every day for artistic expression and for active play, initiated and organized by children themselves, with adult supervision. For older students, strive to keep the spirit of play alive by creating intellectual and social challenges that engage each student's personal gifts of artistic expression. Music, painting, dance, drama, sculpture, poetry, and storytelling should be available to every child as subjects in their own right as well as woven into the fabric of other academic subjects. Help children develop a sense of themselves as active, valued participants in every facet of life—the sense they will need to take part in democratic decisions about the

development and use of technologies in the crafting of the larger world around them as adults.

4. **Put community-based research and action at the heart of the science and technology curriculum.**

Community-based research means embedding children's education in the relevance of their own lives. For the very youngest children, this can be quite simple—help children explore the tiny wonders, like ants and weeds, for example, in their own backyards. Older children can root their social studies in the oral histories of elders who can share the cultural, civic, and even ecological history of their communities with them, as well as help them reflect on the changes they have seen.

Middle- and high-school students can tackle community-based research projects that explore local or school issues, combined with some kind of public sharing of the results. They can then act to make sure that their results are used in a practical way—contributing to a school board's or city council's decision-making, for example. When appropriate, students can draw on their own high-tech skills in conducting such research for their communities. Such practical experience, rooted in local realities, is ideal education for helping students develop wisdom, emotional connections, and skills for democratic engagement on technical issues.

5. **Declare one day a week an electronic entertainment–free zone.**

This simple, powerful step could do much to revive the culture of childhood, family life, neighborhoods, and urban and rural community life. Coordinate that day with others in your neighborhood, school, and larger community. Turn off televisions, computers, video games, DVD players, cell phones, and radios, and minimize phone calls to create a space to focus undivided attention on face-to-face relationships with each other and with the living world around you. This can also be a time for adults and children to slow down and catch up with themselves and with each other.

Families that have tested this idea report that even adolescents can be woven back into the fabric of family life when electronic distractions are silenced. It creates time and space to develop the habits that are essential to a lifetime pursuit of wisdom: wonder, reflection, the exploration of one's own imagination alone and together with others, and connection to the beauty and goodness of the living world. One day a week can grow into more. Also, consider a family vacation where all high-tech tools are left behind. Such steps can go far in helping children experience boundaries and restraint in the use of technology.

6. **End marketing aimed at children.**

Marketing aimed at children has become a public health hazard. Research has clearly established that children under age 8 "developmentally are unable to understand the intent of advertisements and, in fact, accept advertising claims as true."[20] In other words, there is strong scientific evidence that young children are not fair marks for ads.

Even adolescents have trouble withstanding the pressure of marketing. Brain-imaging studies indicate that the regions that govern impulsivity and critical judgment do not fully mature and connect to each other until the late teens or even after.[21] Adolescents may therefore be less able than adults to resist the psychological manipulation of modern marketing techniques.

Marketers understand this. They research ways to build brand loyalty at ever younger ages.

Companies now spend an estimated $15 billion a year on marketing directly to children age 12 and younger.[22] At the heart of this industry is sophisticated research into the manipulation of children's feelings, insecurities, and behavior. This campaign of corporate propaganda on children undermines their most basic right—the right to freedom of thought. That right supersedes any corporation's

claim to freedom of speech—a right originally intended for individuals, not corporations. Sweden, Norway, and Finland have now banned marketing to children under age 12; Quebec bans marketing to children under 13.[24] In the U.S., campaigns against marketing to children and teens have only just begun.[25] It is time for parents, medical professionals, and other citizens to stop corporations from wreaking havoc on the health of our children.

7. **Shift spending from unproven high-tech products in the classroom to children's unmet basic needs.**

It is a national disgrace that one of every six U.S. children grows up in poverty.[26] Many come to school hungry or malnourished. Far too many attend classes in rooms with peeling paint, leaky ceilings, and more children than desks. These children's unmet low-tech needs are far more critical to their success than access to computers.

To be truly technologically literate is to recognize the larger context of human needs within which all technological choices are made. In a time of shrinking school budgets, our priorities should reflect our commitment to children's welfare and to proven interventions.

Spending billions of tax dollars to overcome a "digital divide" when computers have had little impact on student achievement even in the best of conditions makes no sense. The real issue is not a digital divide but an educational divide. Public schools are struggling to attract and retain qualified teachers, maintain or expand breakfast programs (proven to improve children's learning[27]), provide books for all students, and reduce class sizes. Spend those dollars where they will do the most good, especially in poor communities.

"We are learning the fundamental principle that ethics is everything,"
writes biologist Edward O. Wilson.

"We will not fight to save what we do not love."
—Stephen Jay Gould

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2 Bill Joy, "Why the Future Doesn't Need Us," *Wired*, April 2000.

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4 As recounted by Edith Hamilton: "Daedalus was the architect who had contrived the Labyrinth for the Minotaur in Crete, and who showed Ariadne how Theseus could escape from it. When King Minos learned that the Athenians had found their way out, he was convinced that they could have done so only if Daedalus had helped them. Accordingly, he imprisoned him and his son Icarus in the Labyrinth, certainly a proof that it was excellently devised since not even the maker of it could discover the exit without a clue. But the great inventor was not at a loss. He told his son, 'Escape may be checked by water and land, but the air and the sky are free,' and he made two pairs of wings for them. They put them on and just before they took flight, Daedalus warned Icarus to keep a middle course over the sea. If he flew too high the sun might melt the glue and the wings drop off. However, as stories so often show, what elders say youth disregards. As the two flew lightly and without effort away from Crete, the delight of this new and wonderful power went to the boy's head. He soared exultingly up and up, paying no heed to his father's anguished commands. Then he fell. The wings had come off. He dropped into the sea and the waters closed over him." (Edith Hamilton, *Mythology: Timeless Tales of Gods and Heroes*, New York: New American Library, 28th printing, 1942.)

5 The Yupiac society of Alaska, for example, traditionally relied heavily on the seal as a source of food, oil for light and warmth, clothing, and other tools. They took great care in removing and drying the bladders of the seals they hunted because they believed the spirit of the seal that "gave itself"

to the hunter entered its bladder when it gave up its life. They would save the bladders for the winter Bladder Festival to honor this spirit's gift. "During the festival, the bladders were reinflated with life-giving air and hung on poles . . . At the conclusion of the Bladder Festival, the bladders were taken down, deflated, and carried to the ocean or river where an opening in the ice had been made. With collective mindfulness of all the Yupiac participants that the spirits of the animals were happy and satisfied with the care and careful execution of the required rituals and ceremonies, and that they would return and give themselves to the hunters, the bladders were returned to the sacred gift of the element of water, the womb of creation." (Angayuqaq Oscar Kawagley, "Earth, Air, Fire, Water, and Spirit as a Foundation for Education," *Sharing Our Pathways*, newsletter of the Alaska Rural Systemic Initiative of the Alaskan Federation of Natives, the University of Alaska, and the National Science Foundation, vol. 1, no. 4, Nov./Dec. 1996.)

6 Mircea Eliade, a historian of religion, explores the rites, symbols, and myths related to technologies in early and traditional societies in Africa, the Middle East, and Asia and the attitude of "sacred respect" towards the material world. Eliade explains these cultural practices and attitude in terms of "the spiritual adventures" that human beings embarked upon "when they found themselves aware of their power to change the mode of being of substances." For example, speaking of the sacred power many cultures traditionally attributed to metals, Eliade writes:

> All these beliefs do not stop at the sacred power of the metals but extend to the magic of the instruments. The art of creating tools is essentially superhuman—either divine or demoniac (for the smith also forges murderous weapons). Remnants of ancient myths belonging to the Stone Age have probably been added to, or woven into, the mythology of metals. The stone tool and the hand-axe were charged with a mysterious power; they struck, inflicted injury, caused explosions, produced sparks, as did the thunderbolt. The ambivalent magic of stone weapons, both lethal and beneficent, like the thunderbolt itself, was transmitted and magnified in the new instruments forged of metal (Mircea Eliade, *The Forge and the Crucible: The Origins and Structures of Alchemy*, Chicago: University of Chicago Press, 1978; pp. 29-30.)

See also, for descriptions of rituals, myths, and attitudes towards tools and technologies among different African traditional cultures, Colin M. Turnbull, *Man in Africa: From Cairo to the Cape of Good Hope*, Garden City, NY: Anchor Press/Doubleday, 1976. For related traditions among indigenous peoples of the Americas, see *All Roads Are Good: Native Voices on Life and Culture*, Washington, D.C.: Smithsonian Institution Press in association with the National Museum of the American Indian, Smithsonian Institution, 1994; Carl Waldman, Encyclopedia of Native American Tribes, New York: Facts on File Publications, 1988; and Clyde Kluckhohn et al., Navaho Material Culture, Cambridge: The Belknap Press of Harvard University Press, 1971.

7 Myths and traditions in many cultures portray the development of technologies and tools as gifts to human beings from divine beings. The 17th -century Chinese author Sung Ying-Hsing, for example, in a chapter meticulously describing the making of silk, beginning with the care of silkworm eggs, states: "The ingenious loom was first invented by a divine maiden, who brought the skill to mankind" (*Chinese Technology in the Seventeenth Century*, Mineola, NY: Dover Publications, 1997; p. 35). In many traditional cultures, including Native American, particular animals and plants that were key to their physical survival were considered sacred. Corn was sacred to the Pueblo peoples of the Southwest. The Oglala Lakota refer to the buffalo as "brother," and have passed down accounts of the sacred pipe and several key ceremonial rites, including initiation rites for young men and women, as having been directly given to the people by White Buffalo Cow Woman. According to anthropologist Joseph Epes Brown, to the Lakota the buffalo was "the most important of all four-legged animals, for it supplied their food, their clothing, and even their houses, which were made from tanned hides. Because the buffalo contained all these things within himself, and for many other reasons, he was a natural symbol of the universe, the totality of all manifested forms. Everything is symbolically contained within this animal: the earth and all that grows from her, all animals, and even the two-legged peoples; and each specific part of the beast represents, for the Indian, one of these 'parts' of creation." (Joseph Epes Brown, *The Sacred Pipe: Black Elk's Account of the Seven Rites of the Oglala Sioux*, Norman, Oklahoma: University of Oklahoma Press, 1975.)

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15 Linda Jean Shepherd, *Lifting the Veil: The Feminine Face of Science*, Boston: Shambhala Publications, 1993, p. 72.

16 Stephen Jay Gould, "Enchanted Evening," *Natural History*, September 1991.

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18 We draw here from the work of David Orr of Oberlin College. Orr, a leading environmental educator, has contrasted the pursuit of "fast knowledge," and the rush to apply it as quickly as possible regardless of our relative ignorance about the consequences, to the cultivation of "slow knowledge," based on a close reading of nature and a careful consideration of consequences before we develop new products or processes based on scientific advances.

19 See *Greening School Grounds: Creating Habitats for Learning*, published by *Green Teacher* Magazine.

20 Committee on Communications, American Academy of Pediatrics, Policy Statement: "Children, Adolescents, and Advertising" (RE9504), Chicago: American Academy of Pediatrics, 1995.

21 See Chapter 6 for references to this brain research. Behavioral research also has indicated that adolescents are more likely to make choices to comply with authority figures than are young adults, less likely to recognize the risks involved in their choices, and, when they do perceive the risks, they may lack the developmental maturity to align their behavior to avoid those risks. (*MacArthur Juvenile Competence Study*, Chicago: John D. and Catherine T. MacArthur Foundation, www.mac-adoldev-juvjustice.org, accessed February 13, 2004.)

22 Juliet Schor, "Those Ads Are Enough to Make Your Kids Sick," *Washington Post*, Sept. 12, 2004, p. B04.

23 Two recent comprehensive and meticulously researched books on this issue are Susan Linn's *Consuming Kids: The Hostile Takeover of Childhood*, New York: New Press, 2004, and Juliet Schor's *Born to Buy: The Commercialized Child and the New Consumer Culture*, New York: Scribner, 2004.

24 Linn, op. cit., p. 218.

25 A coalition called Stop Commercial Exploitation of Children, based at the Judge Baker Children's Center of Harvard Medical School, is actively working on the problem; see http://www.commercialexploitation.com. For a parents' bill of rights regarding marketing to children see http://www.commercialalert.org/pbor.pdf.

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Chapter 2

What's Wrong with a High-Tech Childhood?

Are we actually teaching our children a kind of technology il*-literacy that leads to illness? A 2004 study, published in the British medical journal* The Lancet*, linked watching two or more hours of television a day in childhood and adolescence with serious long-term health risks. Researchers followed 1,000 children from birth through young adulthood and found a strong correlation between TV watching and obesity, raised blood cholesterol, smoking, and poor cardiovascular health.*

The Values of the "Money World"

All of us want the best for our children. We want them to enjoy childhood and to grow and thrive. We also want them to succeed in an uncertain future.

So it is understandable that many people assume that immersing children in advanced technologies will prepare them for a highly competitive job market. They think that's what technology literacy is all about.

And even for those who are skeptical of the high-tech life style, it's not easy to resist it. Many parents and teachers can't imagine juggling all they have to do without television, videos, video games, computers, handhelds, and cell phones helping to keep the children entertained and occupied. We struggle with increasingly stressful work lives, both aided and complicated by the speed and portability of new communication devices that have turned homes into satellite offices, open every day and night. And, frankly, many of us spend a high percentage of our own leisure time immersed in one electronic form of entertainment or another. What

"In the pursuit of profits, American business—driven by technology—increasingly recognizes no limits, no boundaries, no traditions."

—Enola G. Aird

would we do if our children did demand more of our personal attention?

We don't seem to have time or energy to walk, even if we live in pedestrian-friendly neighborhoods, which many families do not. So we drive our children everywhere, often in super-sized vehicles. How about sharing a home-cooked family meal? Often we barely find time for the packaged, highly processed alternatives, engineered to appeal to our taste for sugar, fat, and novelty. Our children are inundated with ads for these products. Food marketers have even researched how best to coach them to whine until we give in.[1]

And why should we resist? Relaxing in front of the tube with fast food and soft drinks now seems like "quality" family time. At least everyone's together, even if the screen is the only one that gets to talk.

Consider the all-too-common alternative: each family member alone in a different room, snacking on junk food and having his own private electronic experience. Many very young children can now channel-surf their own personal TV in their bedrooms.

Verizon Communications marketed its wireless internet service in June 2004 by offering a free home networking router that would restore "family harmony" by allowing every family member in the house to access the internet at the same time—but not together. "Imagine if everyone in your family could go online at once," the Verizon ad suggested. "Imagine how well you'd all get along…. Just think, you could be out on the deck surfing the Net while your kids are online upstairs."[2]

A growing number of parents, educators, and health professionals are expressing reservations about the long-term consequences of high-tech childhood. "In the pursuit of profits, American business—driven by technology—increasingly recognizes no limits, no boundaries, no traditions," says Enola G. Aird, director of the nonprofit Motherhood Project.[3]

These values of the "money world," Aird adds, "are increasingly at odds with the values necessary for raising human children, what I call the values of the 'motherworld,' values such as sacrifice and self-giving, discipline and moderation, humility and forbearance, commitment and dedication.... In the money world, our children are means to ends. They are subjects of research. They are workers, consumers, and producers. They are means to maximizing sales. They are means to advancing technological and economic progress."

Technology Illiteracy: A Growing Health Hazard

This is not to suggest that every junk-food meal and every half hour of television is harmful, or that families should never gather around a screen. It is to question whether we are in a state of denial and learned helplessness in responding to increasing evidence of the negative effects of high-tech childhood.

"Dysfunctional families, depression, youthful violence, and the rising use of chemicals to sedate children are symptoms of something larger," suggests ecologist David Orr of Oberlin College. "Without anyone intending to do so, we have unwittingly begun to undermine the prospects of our children and, at some level, I believe that they know it."[4]

Are we actually teaching our children a kind of technology *il*-literacy that leads to illness? A 2004 study, published in the British medical journal *The Lancet*, linked watching two or more hours of television a day in childhood and adolescence with serious long-term health risks. Researchers followed 1,000 children from birth through young adulthood and found a strong correlation between TV watching and obesity, raised blood cholesterol, smoking, and poor cardiovascular health.[5]

The researchers could not locate enough subjects who watched no TV as children to measure the health effects of that practice. But they did find that adults who had watched television between one and two hours on weeknights as children rated more poorly on all of the health measures above than those who had viewed less than an hour a day. The researchers concluded that the American Academy of Pediatrics was on the right track in recommending that parents limit children to an hour or two of TV a day. But their data, they said, suggest that "less than one hour a day would be even better."

In an accompanying article, obesity researchers urged immediate action. "Measures to limit television viewing and ban food advertisements aimed at children are warranted, before another generation is programmed to become obese," wrote David Ludwig of Harvard Medical School and Steven Gortmaker of the Harvard School of Public Health.[6]

Health issues aside, are we teaching children to be creative and responsible in wielding technological power? Or are we training them for passive dependency? Are we teaching them about the wisdom of setting healthy limits in the design and use of technologies? Or that neither adults nor children are really free or powerful enough to set limits?

Research across a wide variety of fields indicates that children need face-to-face and hands-on relationships with the living world for healthy intellectual, emotional, social, and physical development.[7] From the earliest ages, many children are now instead immersed in a high-tech world dominated by flat screens, paved-over spaces, and adult-sized pressures.

- Four and a half hours per day, on average, spent in front of TV, computer, and video game screens, often alone.[8] A fourth of children under age 2 have TVs in their bedrooms, as do nearly a third of children 2 to 7, and nearly two-thirds of children 8 to 18.[9] New electronic toys encourage children to get back to their screens by moving or "talking" in response to what's happening on their tied-in TV shows or DVDs. Dolls now have their own "secret" online diaries.[10] Many video games are appallingly violent and extremely realistic; research shows that playing such games desensitizes children to human suffering.[11]

- An average of one hour a day spent strapped into a car seat,[12] increasingly with a TV screen in front of the child's face, and often stalled in traffic in fuel-guzzling vehicles that contribute to ozone pollution and increase health risks, especially for the growing number of children suffering from asthma.[13]

- The loss of music, art, time for imaginative play and recess, and other creative outlets in school to a growing emphasis on computers and standardized tests—which are increasingly designed to be evaluated and scored by computer. "Since the arts aren't government tested—like reading, writing, and math—there's more pressure to cut them," a Wisconsin principal explained to his local paper.[14]

- Fast-food meals that are loaded with sugar and fat and are marketed directly to children through sophisticated multi-level media campaigns. One result: 10 percent of

children ages 2 to 5 are overweight. For ages 6 to 19, the rate of obesity is 15 percent. Since 1980, the rate has doubled for children 6 to 11, and tripled for adolescents. So serious is the long-term risk of heart disease, stroke, and diabetes from this epidemic that medical experts say today's children may be the first generation not to live as long as their parents.[15]

- The ubiquitous presence of pornographic images on the internet where, in spite of parents' efforts, children still have frequent access to them. As of July 2003, there were 260 million pages of pornography online.[16] But children don't have to search for them. One recent survey concluded that more than 80 percent of school-age children are exposed daily to lewd, inappropriate, or dangerous material online through e-mail spam at school and at home.[17] Some researchers suggest that childhood use of porn may distort children's developing sexuality and encourage sexually abusive behavior in adulthood.[18]

- At least 4,000 online hate sites, with racist, anti-Semitic, and gay-bashing themes, that are easily accessed by children. Some are bogus "educational" sites, like one about Martin Luther King, Jr., posted by a racist group. Some encourage visitors to play hate games, such as tracking and shooting illegal immigrants. Others actively recruit young people to violent gangs, or, in the most recent trend, to terrorist acts like suicide bombings.[19]

- An intensifying blitz of ads aimed at children. By one estimate, $10 billion of the $30 billion that companies spend to advertise food and drink targets children.[20] Since the 1960s, when children were first identified as a lucrative audience, marketing efforts aimed at them have skyrocketed, including television ads; billboards and bus shelter ads near schools; ads on city buses and taxis; school field trips to corporate sites; product placement in movies, TV shows, music videos, and video games; online "advergames";[21] and marketing to the captive audience in schools—including embedding corporate messages in the curriculum.[22]

- Intense pressures on children to compete against one another and to overschedule their free time with activities that are intended to build children's "resumes" for admission to elite colleges and to keep them busy while parents are preoccupied with their own work. Researchers at Columbia University found that pressures to achieve and isolation from busy parents were related, in affluent suburban families, to depression among middle-school girls and substance abuse among middle-school boys. The researchers cited "maladaptive perfectionism" on the part of parents, and "a ubiquitous emphasis on ensuring that children secure admission to stellar colleges."[23]

Meanwhile, mental health and behavioral problems in childhood are on the rise. The National Association of School Psychologists (NASP) in 2003 advised elementary school principals on how to deal with "a growing trend in violent behavior among young children." One of the likely causes, the group noted, is "the loss of social development time in the early elementary classroom."[24] A separate NASP report noted "the increased stress and fracturing of life today" in urging principals to make children's healthy emotional and social development at school a higher priority.[25]

Central to the loss of social development time is the demise of play in the early childhood curriculum and of recess for older children. The growing focus on academics in preschool and kindergarten has made playtime obsolete in many classrooms. The increase in academic pressure and testing has been cited as a major cause of a new brand of "kindergarten rage."[26] Children also spend less time at home in unstructured play, both indoors and outdoors.[27]

"Without anyone intending to do so, we have unwittingly begun to undermine the prospects of our children."
—David Orr

Childhood Takes Time

The pressure on children to be ahead of the curve is accelerating. Yet the timetable for children's neurological development is unchanged. New imaging studies of the developing human brain show that the nervous system matures slowly and that human development is biologically grounded in carefully orchestrated patterns of growth. Healthy neural branching of the developing brain depends on close personal relationships with caring adults[28] and on hands-on experiences in the real world.[29] All of this takes time.

Cognitive development, says psychologist William Crain, "has a certain natural slowness," and individual children have their own optimal pace. The slow pace is marked by behavioral and motivational phases that correspond to biological patterns of growth that are now traceable through scans of the developing human brain. That means the speed of childhood cannot be mechanically calibrated. "Children, like plants, grow according to nature's timetable," writes Crain.[30]

The rush to fill classrooms with computers and internet connections has been partly supported by claims that computers give children more control and power over their own learning. But more than 30 years of studies show that computers do not necessarily improve education, that they quickly become obsolete, and that their high cost can mean less money for proven educational reforms—including smaller class size and integrating the arts in academic classes. In Florida, for example, state officials have argued for backing away from a plan to reduce class size, in part to free up more money for computers.[31]

School imposes adult patterns of long hours of sedentary work without breaks for physical exercise. Recess is being reduced or eliminated at many elementary schools. Atlanta, for example, eliminated recess ten years ago and no longer builds playgrounds at new schools,[32] despite research showing that children with 20 minutes of recess stay on task better and fidget less.[33] One of the main reasons given for eliminating recess is to free up more time for test preparation. The emphasis on standardized testing at all ages, even now in Head Start programs and some other preschools, is itself an oversimplified technical fix to the complex question of how to educate all of our children well.

Consider the experience of Garfield-Franklin Elementary School in Muscatine, Iowa, which has concentrated successfully on raising its standardized test scores. Children there no longer have time to watch eagles from canoes on the Mississippi River, go on field trips to the University of Iowa's Museum of Natural History, or have two daily recesses. Creative writing and social studies have become "occasional indulgences. Now that the standardized fill-in-the-bubble test is the foundation upon which public schools rest...there is little

Florida officials have argued for backing away from a plan to reduce class size, in part to free up more money for computers.

time for anything else." Despite their higher standardized scores on reading and mathematics tests, students' writing skills have deteriorated. Teachers read fewer imaginative storybooks to them, and more lesson-related nonfiction. Teachers also bemoan "a loss of spontaneity, breadth, and play."[34]

Screened In from the Real World

Concerned about a broad range of potential developmental problems, the American Academy of Pediatrics recommends that children under two not be exposed to screen media at all and that older children have no more than an hour or two a day of "quality" screen time—but not at mealtime and only after children have played outside, read or been read to, and spent time in other more active pursuits. The academy also advises parents to keep TVs, VCRs, video games, and computers out of children's rooms so parents can monitor both the time and the content of children's media exposure, and make sure it does not cause sleep deprivation, a growing problem.[35]

A 2003 survey of parents by the Kaiser Family Foundation found that 26 percent of children under age two have TVs in their bedrooms. On any given day, 68 percent of children under two will sit in front of a screen and will spend an average of two hours and five minutes doing so, the Kaiser survey reported. The study also found that a third of children live in households where the television is left on all or most of the time. These children are less likely to read; when they do read, they spend less time reading, and are less likely to be able to read well. They also spend less time playing outdoors.[36]

"It's not just teen-agers who are wired up and tuned in, it's babies in diapers as well," said Vicky Rideout, Vice President and Director of the Kaiser Family Foundation's Program on the Study of Entertainment Media and Health. "So much new media is being targeted at infants and toddlers, it's critical that we learn more about the impact it's having on child development."[37]

Parents are trying to set limits, with limited success. Children report fewer parental limits on their use of video games and online surfing than parents do. "Roughly half of parents say they limit video game playing time and check ratings to select game purchases," the Kaiser Foundation reports, "but only 13 percent of kids report time limits and fewer (7 percent) say their parents did not allow them to purchase a game because of its rating. Likewise, a majority of parents say they enforce time limits on internet use, surf together, and check up on sites their children have visited, but most teens say they do not have time limits or go online with their parents, and less than one-third believe their parents have ever checked where they have gone online."[38]

Yet 56 percent of parents express concerns about the harmful effects of the time their children spend online. And nearly two-thirds of children ages 12 to 17 in one poll said that the time they spent online reduced their family time, and that the internet keeps other children their age from doing more important things.[39]

Earlier studies showed that television viewing interferes with family conversations and family relationships.[40] Now the even broader set of electronic distractions, including computers, headsets, and cell phones, has made it possible for children and parents almost to avoid each other's company entirely, even when sitting next to each other in

the same room or the same car, suggests Michael Brody, chair of the Media Committee of the American Academy of Child and Adolescent Psychiatry.[41]

Electronic Power Can Exceed Children's Emotional Maturity

Even where strong family relationships exist, the power of electronic toys can be dangerous in the hands of children, who are, by definition, neither emotionally nor morally mature. In Ireland, school officials are under pressure to ban cell phones with digital cameras after a child was photographed partially clothed and the pictures were broadly distributed via other digital camera phones. Schools in the U.S. are discussing limiting or banning their use in locker rooms and elsewhere to avoid student voyeurism and cheating.[42]

Girls ages 13 to 18 in a 2001 survey commissioned by the Girl Scouts of the USA reported that they frequently encountered pornography online. About a third reported having been sexually harassed in a chat room but only 7 percent of those girls had told a parent about it. They also don't think their parents worry enough about their online behavior, especially lying and cursing, or about what kind of people they could run into online, or what information they can access if they want to. They reported often feeling "freaked out" by the information they are exposed to online and not knowing how to respond to online sexual harassment.

"With little adult advice that is relevant to their online lives, girls are often put in emotionally complex situations with limited guidance," the survey concluded. "Because girls are forced to navigate potentially difficult or emotional situations online with little pertinent and useful advice," it added, "they are in effect driving the information highway without a license."[43]

The *New York Times* reported a disturbing increase in the amount and severity of online bullying and sexual harassment through e-mail and web logs that "enable the harassment to be both less obvious to adults and more publicly humiliating, as gossip, put-downs and embarrassing pictures are circulated among a wide audience of peers with a few clicks. The technology, which allows its users to inflict pain without being forced to see its effect, also seems to incite a deeper level of meanness. Psychologists say the distance between bully and victim on the internet is leading to an unprecedented—and often unintentional—degree of brutality, especially when combined with a typical adolescent's lack of impulse control and underdeveloped empathy skills."[44]

Equally troubling is the likely impact of the violent video games that have become popular among young boys and adolescents. Chain stores routinely sell the most gruesome of these games to children, and many parents routinely allow their young sons to spend hours in this kind of "play," pretending to be criminals assaulting women, stalking African-American victims, and killing police officers. When parents do ban violent games at home, children find relatively easy access to them at friends' houses, at the local shopping mall, even at popular family restaurants.

Research suggests that violent video games are anti-social. Four studies published in the February 2004 issue of the *Journal of Adolescence*, for example, concluded that playing violent games is associated with children getting lower grades, arguing with teachers, being less empathetic to others, approving of physical aggression, and being more likely to get into fights themselves. The last finding held true even in comparing students with non-aggressive personalities who play the games to students with aggressive personalities who do not play the games. And forensic psychiatrists describe video games as ideal training for anti-social behavior.

Computers, headsets, and cell phones have made it possible for children and parents almost to avoid each other's company entirely, even when sitting next to each other.

"It used to be that you were the good guy out to save the planet from aliens; now the trend is that you are the thug stalking and killing innocent people to win points," says Cathy Wing of Media Awareness Network, an educational organization in Ottawa. "When the most marginal and vulnerable in society are beaten to death with baseball bats and it's deemed entertainment, just what does this say about us as a society?"[45]

The American Academy of Pediatrics has called the negative influence of mass media on children a major public health concern. After the shooting at Columbine High School, Les Moonves, the president of CBS, pretty much agreed. You would have to be "an idiot," he said, to deny that the media had something to do with it.[46] In 2000, six major health organizations together testified to Congress that more than 1,000 studies "point overwhelmingly to a causal connection between media violence and aggressive behavior in some children."[47]

Indeed, many studies suggest that watching television itself, regardless of the content, is associated with increased aggression.[48] Pediatrician Michael Rich, director of the Center on Media and Child Health at Children's Hospital in Boston, cites clinical evidence that just having a TV set on constantly in the background at home is akin to exposure to second-hand smoke. As children get older, he adds, they are likely to be more jittery, irritable, and aggressive.[49] Most recently, researchers uncovered evidence that children who watched television at the ages of one or three were at increased risk of attention deficit problems by age seven, including difficulty concentrating, restlessness and impulsive behavior, and easily getting confused, and that the risk increased by 10 percent for every hour they watched daily.[50]

The Effects of High-Tech Life on Children's Bodies

Ergonomic experts Alan Hedge of Cornell University and Karen Jacobs of Boston University cite the risk of repetitive stress injuries to children and adolescents from poor posture and long sessions staring at screens; punching keys on computers, laptops, handhelds, and cell phones; or hitting the "fire" button repeatedly on video games.[51] The last-named problem has given rise to the term "Nintendo thumb" in the medical literature as well as warnings that game producers now include with their products.[52]

Studies by Jacobs, former president of the American Occupational Therapy Association, have found about 40 percent of middle-school students reporting musculoskeletal pain related to using computers.[53] She is currently studying whether the time students spend playing video games and/or the weight of their backpacks is combining with computer use to cause additional problems.

Jacobs strongly recommends that parents and teachers make sure students take physically active breaks from keyboards or video games every 20 minutes, that they learn to check their chairs and screen height each time, and adjust them if necessary, and that they be taught the proper position for typing to avoid strain. "We're going to have a whole generation of kids going into the workforce who are hurting," she predicts.

Jacobs and Hedge emphasize that more research, public attention, and action is needed on this issue to protect children. But there are few sources of

funding for such work in the United States and no national database to track this health issue. Hedge notes that neither schools nor technology vendors seem eager to participate in research that may have liability repercussions. "Ignorance is the best defense," he says.[54]

Because injuries can take years to develop, his immediate concern about children's computer use at school is that they are forming bad ergonomic habits that will set them up for later workplace injuries. If computer technologies become ubiquitous across the curriculum from preschool on up—as the No Child Left Behind Act and current educational technology standards envision[55]—Hedge says that children are likely to suffer not just pain but actual injury unless action is taken to prevent it. Laptops are more of a problem ergonomically, he adds, because the screen and keyboard are attached. That makes it difficult to have each in a healthy position. Laptops also add more pounds to students' already too-heavy backpacks, which are a growing health concern.

Unanswered questions persist also about whether electromagnetic radiation from cell phones poses long-term health risks to children.[56] Preliminary results in 1999 from studies by the cell-phone industry which were never published indicated, according to the lead researcher, a potential link between use of the phones and cancer,[57] and the federal government is now funding a follow-up study by the industry. Critics have complained that the pace of the research on what could turn out to be a major public health concern has been slow.[58] Given current ads encouraging parents to buy their children cell phones with packages promoting large numbers of "free minutes," and the intensity of the new cell-phone culture among preteens and teens, the unanswered health questions are troubling.[59]

In the United Kingdom, an independent group of expert advisers to the government recommended in 2000 that "the widespread use of mobile phones by children for non-essential calls should be discouraged," and that "the mobile phone industry should refrain from promoting the use of mobile phones by children." The panel said these precautions were wise given the need for more research and the possibility that children are more vulnerable because of their developing nervous systems and a longer lifetime of exposure.[60] Expert groups in some other countries, such as the German Academy of Pediatrics, have also called for parents to limit children's use of wireless phones.

Dr. Lief Salford of Lund University in Sweden has called the rapid expansion around the globe of cell phone use "the largest biological experiment in the history of the world," and cautioned that the growing brains of children and adolescents may "deserve special concern, since biological and maturational processes are particularly vulnerable."[61]

Childhood as an Environmental Issue

One reason indoor passive amusements are so attractive to children is the fact that few outdoor spaces remain for children to play, walk, or safely ride their bikes. Even many playgrounds are relatively sterile, manufactured environments.

Children age 5 and younger spend an average of about 65 minutes a day being driven around in vehicles, according to the federal government's National Household Travel Survey, released in 2003. Children 6 to 18 spend about 61 minutes a day in vehicles—not including the time they spend on school buses. Part of that travel time is accompanying adults on errands, but it also includes the time to move through their own carefully orchestrated round of activities.[62] Being stuck in a traffic jam is one more stress on family life, as well as reducing the time for the best stress relievers: play and exercise.

"It's certainly a worry that when kids are in cars, they're not out doing other things," said Daniel Swartz, former executive director of the Children's Environmental Health Network. "We're designing

cities, school systems, neighborhoods, and life styles in a way that we can only get kids to things in cars."[63]

Americans have led the world for six decades in saturating the Earth's atmosphere with carbon. Our children and grandchildren will suffer the consequences, especially as China and other developing countries add their demands for carbon-spewing vehicles to the mix. Many children are already suffering, as demonstrated by the 2000 study on ozone and childhood asthma, cited earlier in this chapter.

Our media culture has given birth to a different kind of pollution that is internal. The Parents Television Council has documented the increasing "raunchiness" of prime-time television.[64] The acceleration of that trend in the last ten years, some critics add, was aided by MTV's pushing the boundaries of misogyny, irresponsible sexuality, violence, and general crassness.[65] Researchers reported in 1990 that viewing music videos tended to improve the mood of boys between the ages of 9 and 15, but that the mood of girls of the same ages tended to be much worse than average while viewing them.

"We believe that it is the imagery itself in music videos that results in different reactions of boys and girls," reported Robert Kubey of Rutgers University, who helped conduct the research. "Music videos present a great deal of violent and sexual imagery and are male-oriented and in harmony with male interests. They also frequently present women as sex objects and in states of undress and are thus likely to seem particularly threatening to girls who are just coming to terms with their own sexuality."[66]

What would have been shocking a few years ago draws a yawn today. The landscape includes voyeuristic "reality" TV, more lenient ratings for violence and crudeness in films,[67] viciously antisocial video games,[68] mainstream toy retailers selling bombed-out dollhouses to kindergartners,[69] and divorce lawyers citing the prevalence and popularity of graphic pornography—especially online—as a major new factor in the breakup of marriages.[70]

Character Miseducation

With so many children immersed in the world of advanced electronic media, advertising has become the most pervasive instructional experience in childhood today related to character issues. Children now spend more time engaged with electronic media than in almost any other activity.

The commercial assault on children, which has become an estimated $15-billion-a-year industry,[71] is fueled by behavioral research on how to manipulate the feelings and buying behavior of both parents and children.[72] Marketers systematically search for and exploit children's and adults' weaknesses and vulnerabilities. Their aim is to sidestep the developing ability to reason and make critical judgments, and to tap into primal emotions and needs. They seek to trigger, as Stephen Fox suggests, "materialism, sexual insecurity, jealousy, vanity, and greed."[73]

Now there is evidence that the constant stimulation of desire and creation of needs may actually be making children unhappy, even when they have the money to indulge in the products being sold. Barry Schwartz, professor of social theory and social action at Swarthmore College, writes of the "paradox of choice." He suggests that increases in childhood and adolescent depression reflect, in part, the unhappiness that the excess of marketing and consumer choices is breeding in our young. Suicide, he notes, is at much higher levels among American college students than it was 35 years ago.

"The 'success' of modernity turns out to be bittersweet," Schwartz says, "and everywhere we look it appears that a significant contributing factor is the overabundance of choice."[74]

One of the most promising antidotes, Schwarz notes, is the cultivation of gratitude in family life and in the lives of children. Gratitude, it turns out,

provides a degree of immunity from the virus of discontent and unhappiness that our excess of choices about material things creates.[75]

There is evidence that many Americans are waking up to these issues and ready for change. According to a 2003 poll by Common Sense Media, 9 out of 10 parents believe that exposure to the media is contributing to children becoming too materialistic, using more coarse and vulgar language, engaging in sexual activity at younger ages, experiencing a loss of innocence too soon, and behaving in anti-social or even violent ways. "The majority of parents believe that media negatively affect *their own* children this way."[76]

The Next Technological Revolution

The good news is that, with public awareness and cooperative support from every level of society, families and communities can take action to change the technological environment in ways that benefit children profoundly. Examples that this is possible, if often quite difficult, to do include the passing of seat-belt laws and bicycle helmet laws, recent successful public campaigns to stop placing infants and young children in the front seats of cars, and the history of breastfeeding versus artificial milk.

The last example demonstrates that even when commercial interests promote a less healthy product over a simpler and more natural alternative, it is possible for families, with information and social supports, to shift back to healthier options. Early on, companies marketed formula by suggesting that mothers' own milk supply might be inadequate and that formula would complement it. Later, they pressed the argument that formula was an excellent, scientifically designed substitute for breast milk, which tapped into growing public enthusiasm for new products. Eventually, many new mothers were actively discouraged from breastfeeding by hospital staff and given free samples of formula to take home with their babies. By 1972, only about 25 percent of newborns were breastfed at birth in the United States, and less than 6 percent were breastfed at 6 months. That was the low point, at least in the U.S.

About a third of teen-age girls reported having been sexually harassed in a chat room but only 7 percent of those girls had told a parent about it.

In the 1970s a boycott of Nestlé products to protest its marketing practices focused international attention on the urgency of reviving breastfeeding. Since 1981, when a new international code to prevent inappropriate marketing practices was adopted, health agencies, governments, and nonprofit groups have informed new parents of the benefits of breastfeeding and encouraged them to try it—one of the first international efforts to counter global marketing that harms children. Its success has been significant if by no means total. The U.S., for example, has not reached its goal, set back in 1978, of having at least 75 percent of babies breastfed at birth. But the number is now up over two-thirds.[77]

Technology is not destiny. It is possible for us to reconsider and redirect the impact of technology on childhood. See Chapter 5 of this report for examples of how that is happening across the U.S. and the world. A high-tech childhood is inadequate preparation for the real challenges of civic engagement in a high-tech democracy. We join with thoughtful parents, educators, and policymakers urging immediate action for social change on behalf of a healthy future for children and for the world they will inherit.

"As we think about nurturing children's emotional, social, and ethical development, our entire relationship with technology has to shift," says Linda Lantieri, a cofounder of Educators for Social Responsibility. "Our approach right now seems to be that we engineer life and reality itself to adjust to technology. Instead, we should work to change our relationship to technology so that it responds to our human needs. The challenge is not how we can use technology to change who we are, but rather how we can put the needs of ourselves, nature, and society first and let that dictate our technological progress."[78]

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66 "Researchers Find Gender Differences in Kids' Video Use," *Media Literacy Review*, Media Literacy Online Project, Eugene, Ore.: College of Education, University of Oregon at Eugene.

67 The Harvard School of Public Health released a study documenting "ratings creep" in the movie industry from 1992 to 2003, with the Motion Picture Association of America assigning more lenient ratings for films with more violence and sexual content over time. The study found that today's PG rating is approaching what used to be rated PG-13, PG-13 is approaching what used to be rated R, and today's R-rated films include more explicit sex and more profanity than a decade ago. (Sharon Waxman, "Study Finds Film Ratings Are Growing More Lenient," *New York Times*, July 14, 2004, p. B1.)

68 The game "Grand Theft Auto: Vice City," for example, lets players hijack cars, shoot police officers, kill women with baseball bats, and have sex with prostitutes and then kick them to death and get their money back. It was rated M for "Mature," but, like R-rated movies, that hasn't stopped this game from becoming phenomenally popular with teens and preteens. In 2002, *Entertainment Weekly* named it best game of the year, saying that Vice City "blows every other game away." (Quoted in "Reclaiming Childhood," editorial in the *San Francisco Chronicle*, March 30, 2003.)

69 For background on Forward Command Post, the bombed-out dollhouse marketed for children five and up, and other violent toys, see Bob Herbert, "The Gift of Mayhem," *New York Times*, Nov. 28, 2002. Dollhouse accessories included a machine gun, rocket launcher, magazine belt, and explosives.

70 For connection between online pornography and divorce, see Pamela Paul, op. cit., p. 101.

71 Glendale, op. cit., p. 52.

72 See *San Francisco Chronicle* editorial cited above for an excellent survey on the exploitation of children.

73 Quoted from Fox's 1985 book, *The Mirror Makers: A History of American Advertising and Its Creators*, in Jason Ohler, *Taming the Beast: Choice and Control in the Electronic Jungle*, Bloomington, Indiana: Technos Press, 1999, p. 84.

74 Barry Schwartz, *The Paradox of Choice: Why More Is Less*, New York: HarperCollins, 2004, p. 221.

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77 See "Using International Tools to Stop Corporate Malpractice—Does It Work? Checks and Balances in the Global Economy," Cambridge, UK: Baby Milk Action on behalf of the IBFAN, January 2004; and Barbara L. Philip, Anne Merewood, and Susan O'Brien, "Physicians and Breastfeeding Promotion in the United States: A Call to Action," *Pediatrics*, March 2001.

78 Linda Lantieri, remarks prepared for the Alliance for Childhood's Roundtable on Rethinking Technology Literacy, January 2002.

Chapter 3

A Critique of Current Technology Education Standards

To expect our teachers, our schools, and our nation to strive to educate all of our children, leaving none behind, is a worthy goal. To insist that they must at the same time spend huge amounts of money and time trying to integrate unproven classroom technologies into their teaching, across the curriculum with preschoolers on up, is an unwise and costly diversion from that goal. It comes at the expense of our neediest children and schools, for whom the goal is most distant. For that reason, we urge parents, educators, and policymakers to take a fresh look at current technology education standards.

Technology education has often been narrowly focused on teaching children to use electronic devices. State and local technology education standards increasingly require teachers to integrate computers in lessons for all students—from preschool on up.

The success of this standards movement owes much to the financing, advice, and lobbying efforts of high-tech companies who stand to profit, and to the endorsement of the "all teachers, all students" standard in the federal No Child Left Behind Act.[1]

In this chapter, we look at the evidence—or lack of evidence—supporting these standards, the groups promoting them, and the irony of a recent twist in the story: Computer enthusiasts envisioned technology standards as a way to prod schools to transform themselves into progressive centers of "student-centered" and "inquiry-based" learning. Schools would become places where students' creativity and "higher-order" skills would flourish. Now, however, the high-tech focus has become a part of another powerful educational trend: the increasing emphasis on high-stakes standardized

testing, which many critics see as a serious threat to creativity and individualized teaching and learning.

High-Tech Businesses Win

School-technology vendors[2] have become closely involved with the professional associations promoting the standards and the federal, state, and local agencies that are adopting them and helping distribute tax dollars to implement them. Top Bush Administration officials have made it clear that their emphasis on testing and accountability—codified in NCLB—provides a lucrative market for these companies.

"The large message I want you to walk away with is that every education program found in No Child Left Behind is an opportunity for technology funding," said John Bailey in a 2003 teleconference hosted by PLATO Learning, Inc. Bailey at the time was director of the Office of Educational Technology for the U.S. Department of Education.[3]

The department, Bailey said, is encouraging states to pursue online and computer-based assessments that can give test results in "real time," allow schools to adapt instruction to student needs based on "instant feedback," and embed these tests in instructional software "so you get continuous feedback that customizes and personalizes the instruction for every student." Bailey also suggested that the proliferation of high-tech products in elementary and secondary education has actually made the array of testing and data-management mandates of the controversial federal law feasible.

"If you had asked if we could have implemented this law successfully ten years ago, I don't think we could have," he said. "The reason we can today is because of the technology tools that are out there…. Adequate yearly progress, report cards, assessments, identifying schools in need of improvement, disaggregating data, evaluating program impact, and providing richer data for analysis purposes all are different opportunities for technology to help drive decision-making and to help inform instruction at the local level."

Still Looking for Evidence

By conservative estimates, schools have spent at least $55 billion in the last 10 years[4] on computers and other high-tech products, services, and related training. But there is little solid evidence that these technologies have improved student achievement—let alone that they are cost-effective compared to other interventions. Even some technology proponents concede this.

"It is time to move beyond talking about the potential of technology to change education," said Secretary of Education Rod Paige in 2002, soon after President George W. Bush signed the NCLB Act. "We need to prove it."[5]

"Everyone is asking, 'Show me the effectiveness. Show me why it works,'" said John Bailey in 2003, discussing the need for a $15-million five-year study to evaluate technology's impact on learning, which Congress mandated in NCLB. "In tight budget times, this is even more critical. Otherwise we're asking people to bank on the promise of technology without proving the effectiveness."[6]

In August 2004, Susan Patrick, Bailey's successor as the head of the Education Department's Office of Educational Technology, pointed out that "despite a decade of investment, most achievement indicators are flat."[7]

The Consortium for School Networking (CoSN)—a nonprofit group that lobbies for the increased use of telecommunication and information technologies to improve education—echoed those comments in its brochure for a 2004 symposium. (CoSN has about 100 tech-oriented corporate members and a somewhat larger number of institutional members that include school districts and other education organizations.) "The need for research as a basis for creating ICT [information and communications technology] policy and

informing practice is widely recognized," the brochure stated. "There is little value in reiterating the need for research. Moving from the rhetoric of the importance of research to the reality of creating research literature that impacts effective practice presents many complex issues."[8]

CoSN has partnered with Education Development Center (EDC) to start an online publication called "What Does the Research Say?" In its first volume, Glenn M. Kleiman, director of EDC's Center for Online Professional Education, commented on why students of some teachers scored higher than students of others participating in the same high-tech program in Missouri. The following principle, he wrote, "has been consistently established in research: It is not the availability of technology or professional development, but actual changes in classroom practices that can result in gains in students' learning."[9]

The most popular set of technology education standards in the U.S. today is that of the International Society for Technology in Education (ISTE). ISTE is a professional association for educators and others who support the use of advanced technologies to improve education. David Moursund of the University of Oregon played a major role in its founding; he served as its chief research officer from 1998 to 2001.

But even Moursund still seems to be looking for the evidence that the national investment in computers has paid off. He is now webmaster for an Oregon technology education group. On that group's web site he notes that the question "Why have we not seen significant improvements in our educational system as a consequence of this large and continuing investment?" is one of those "that need to be answered."[10]

Education Week, a leading news source for and about elementary and secondary education, is a member of CoSN and publishes an annual report called "Technology Counts." The newspaper reports that the ratio of computers to students in public schools in the United States grew from 1 to 125 in 1984 to 1 to 4 in 2003.[11]

Top Bush Administration officials have made it clear that their emphasis on testing and accountability—codified in No Child Left Behind—provides a lucrative market for technology vendors.

It also notes the large, federally subsidized expansion of internet connections in K-12 schools in recent years, through the E-Rate discount program. But it cites 2002 research by the National Bureau of Economic Research that found "very little evidence" that access to the internet between 1996 and 2000 in California had made a significant difference in student achievement.

The question of cost-effectiveness remains unanswered. That is, how does the impact on students of integrating computers into education at all levels compare to the impact of redirecting those dollars to other possible interventions such as smaller class sizes or adult or peer tutoring?[12]

A Discouraging Picture of Research

Education Week's summary of two recent meta-analyses of the effectiveness of educational technology does not mention an important caveat in both of those studies. The authors note the generally poor quality of research studies on the impact of high-tech programs in education as a reason not to take the meta-analyses' results too seriously.

One analysis, commissioned by the North Central Regional Educational Laboratory in 2002, found "a small, positive effect on students' cognitive outcomes when compared to traditional instruction."[13] It also found "a small, positive

There is little solid evidence that electronic technologies have improved student achievement—let alone that they are cost-effective compared to other interventions.

effect" for affective outcomes, which apparently refers mostly to improved attitudes towards computers. But it also found "a small, negative effect on students' behavioral outcomes," which appears to relate to students' attendance, although the study does not go into any further detail.

The researchers themselves called their results "discouraging" because "the overall effects are quite modest." They noted that the findings of any meta-analysis are limited by the quality of the studies it synthesizes, and they criticized the overall quality of the 20 studies they had included—all published in the preceding five years—even though they had excluded many other recent studies of even poorer quality.

The other meta-analysis—a review of studies done between 1993 and 2000 on the use of discrete educational software in classroom instruction—was even more blunt. It was done by SRI International under a contract with the Department of Education.[14] Much of the money spent to evaluate the effectiveness of educational software, it concluded, is being wasted because the research is so poorly designed.

The SRI researchers excluded 84 percent of the 195 studies they originally considered because the research designs were so inadequate. That included about two-thirds of the studies of effectiveness that they had collected from companies marketing the software—some of whose products are now in use in thousands of schools. In fact, the sheer number of studies they excluded makes it likely that their findings are biased, the researchers said, "although the direction of that bias is unknown."[15]

They eventually used just 31 of the studies—some of which also had "fundamental flaws." Based on these 31, the researchers found "a positive association between the use of discrete educational software products and student achievement in reading and mathematics," of a size consistent with earlier reviews that have been criticized for not being rigorous enough. But readers, they suggested, "should interpret these findings with caution," and not assume that the positive effects were actually due to the software being studied.[16]

They also concluded that there are wide gaps in what we know about the effectiveness of software use on students' academic achievement. "The current research base," they said, "provides little guidance on program effectiveness and best practices" for policymakers and practitioners because of the scarcity of rigorous studies.

Parents, educators, and policymakers for years have endured a blizzard of propaganda promoting digital classrooms. They may have understandably assumed that the evidence for the technology's effectiveness is fairly solid. It is not. Nor is there a consensus among experts on children's welfare that emphasizing computers in early education is in children's best interests.

We note that in 2000 dozens of respected authorities on education, child development, children's health, and technology signed a call to action issued by the Alliance for Childhood proposing an immediate moratorium on the further introduction of computers in elementary education, except for children with certain disabilities. A time-out was needed, they agreed, to reconsider how the current emphasis on computers in childhood was actually affecting children and to redirect education to the proven healthy essentials of childhood.[17] We also note a series of well-documented

books and articles in recent years that thoughtfully challenge the growing emphasis on high-tech classrooms for young children.[18]

The technology requirements in NCLB make no sense without an assumption that high-tech classrooms are essential for all students and teachers. But the law's mandate for research itself calls that assumption into question. It provides up to $15 million for an "independent, long-term study, utilizing scientifically based research methods and control groups or control conditions." The research is to identify the conditions and practices under which educational technology can increase student academic achievement, technology literacy, and the ability of teachers to integrate technology effectively into their teaching. A final report is to be submitted to Congress by April 1, 2006 and widely distributed. But states and districts would have just nine months after that before their deadline—the end of 2006—for fully integrating technology in schools.

ISTE—"The NETS People"

As noted above, one of the most influential groups promoting technology standards has been ISTE, the International Society for Technology in Education. Originally dominated by those who teach "with and about" classroom technologies, including computer science teachers, college faculty who teach teachers, and school technology officials, it also now includes about 60 corporate members who each pay $5,000 a year to belong. The corporate members of ISTE appear to share a common interest in the ed-tech market. Besides its offices in Oregon, ISTE shares a Washington suite of offices—and a top-notch Washington lobbyist—with CoSN.

ISTE has become known as "the NETS people" for its work since 1989 to write and promote its National Educational Technology Standards, for teachers, for students, and most recently for administrators. The organization reports that 49 of the 50 states and the District of Columbia have "adopted, adapted, aligned with, or otherwise referenced" one or more of its three sets of standards in their own official documents or plans.[19]

ISTE grew rapidly in the 1990s after winning federal, foundation, and corporate support to develop those standards, and a growing number of major professional associations, curriculum groups, and school technology vendors have gotten involved in the project. The 1998 ed-tech standards for students,[20] for example, list Apple Computer, the Milken Exchange on Education Technology,[21] the National Aeronautics and Space Administration, and the Education Department as "co-sponsors, funders, and advisors" of the project. Two officials from the Milken Exchange and one from Apple were also on the "project leadership team" in charge of coordinating the development of the standards.

The list of recent ISTE "partners" in the NETS initiative includes the American Federation of Teachers, the National Education Association, the Council of Chief State School Officers, an arm of the National School Boards Association, and the National Association of Elementary School Principals. It also includes the Software & Information Industry Association and, until recently, the Public Broadcasting Service, both of which have an interest in the ed-tech market.[22] In recent years, Intel Corporation signed on as a major sponsor of ISTE's NETS project. Other companies, such as Microsoft and Teacher Universe, are acknowledged by ISTE as "contributors" to the work that led to the technology standards for school administrators, having helped pay for both their development and dissemination.

ISTE's efforts have thrived in a political climate that has propelled the broader standards movement. Efforts to develop federal education standards in the 1990s failed. But states have adopted standards in math, English language arts, and

science, often based at least partly on standards promulgated by national associations of researchers and educators.

The National Council for Accreditation of Teacher Education requires colleges of education to include a statement of their commitment to technology in their conceptual frameworks (statement of vision and philosophy) for accreditation. Many colleges use ISTE's teacher standards for this purpose. They call for all teachers to be able to infuse information and telecommunications technologies into their curricula.

Unquestioned Assumptions in ISTE's Standards

ISTE's "Technology Foundation Standards for All Students" are in themselves unobjectionable. Like most educational standards, they tend to be general statements, such as "Students demonstrate a sound understanding of the nature and operation of technology systems," and "Students employ technology in the development of strategies for solving problems in the real world," and "Students understand the ethical, cultural, and societal issues related to technology." What is most troubling in the standards is not what they say but what they don't say, and how other ISTE materials interpret them.

The ISTE standards limit their focus on technologies almost exclusively to computers, telecommunications, and other advanced electronics, and to their educational or personal uses.[23] They are written without reference to the real developmental needs of children or to the role of low-tech tools in their healthy growth. Rather, they unquestioningly assume that students should begin operating powerful machines in preschool and that teachers can develop "developmentally appropriate" ways to "apply technology-enhanced instructional strategies" for children of all ages.[24]

ISTE emphasizes that technology, to be effective in education, requires schools to have several other "essential conditions" in place, such as "student-centered learning" and other policies and teaching practices that "support new learning environments." The latter include, for example, multi-sensory stimulation, collaborative work, "active/exploratory/inquiry-based learning," and the promotion of critical thinking.[25] Proponents of the standards, however, seem not to have considered whether these conditions are likely to be created when large amounts of time and money are spent on technology. An elementary curriculum that is rich in the arts and hands-on activities at school and in the community, for example, provides rich opportunities for each of the conditions listed above, but many schools are cutting back on them to pay for more computers and more testing.

ISTE has published extensive supporting literature, including three thick volumes of suggested activities and assessment methods. This material calls for the development of specific technology skills and specific technologies to be used in the classroom at different grade levels. For example, ISTE proposes that, before completing second grade, children should be able to "use input devices (e.g., mouse, keyboard, remote control) and output devices (e.g., monitor, printer) to successfully operate computers, VCRs, audiotapes, and other technologies," and that, with support from adults or other students, they should be creating "multimedia products" and "gathering information" and communicating over the internet.[26] ISTE also suggests that schools and teachers must constantly update equipment and retrain teachers as new technologies appear on the market.

There is no supporting evidence in the standards for the underlying assumption that young children will benefit from these activities. Nor is there discussion of the arguments that have been raised by serious researchers and critics about potential health risks and other reasons to be cautious in promoting these uses of technology by children.

For example, the student standards, published in 1998, make no reference to the musculoskeletal or visual health hazards associated with poor posture and overuse of computers. The teacher standards, published in 2000, do call for teachers to "promote safe and healthy use of technology resources." But just what constitutes safe and healthy use is left vague. ISTE's 2003 guide to assessing teachers suggests that teachers could be assessed on whether they are "aware of issues such as ergonomics."[27] It also recommends that teachers should consider "the effects technology can have on the students physically and psychologically," and adds that one "suggested" piece of evidence that would show teachers are aware of the issue would be "teacher- or district-created guidelines that direct the selection and purchase of ergonomically appropriate furniture and the placement of technology to meet the needs of all students."[28] ISTE's new standards for administrators, published in 2002, also call on administrators to focus on "health and environmentally safe practices related to the use of technology." These suggestions are steps in the right direction. But given the importance of helping children develop good habits early and avoid visual strain and musculoskeletal pain, the ergonomic issue deserves to be far more visible in the NETS Project and more fully and openly treated.

Alan Hedge, professor of ergonomics at Cornell University, has pointed out that maintaining ergonomically sound classrooms would require schools to provide for—and teachers to insist on—properly sized workstations for each child, adjusted as they grow, and a regular classroom discipline of taking breaks from the keyboard about every 20 minutes.[29]

Technology-Centered Learning

ISTE defines the "ethical issues" related to technology as follows: "Those issues that address the ethical use of software, computers, and related technologies by students and educators (e.g., privacy, piracy, integrity of information, responsibility for content, and use of recreational applications.)" And human issues are defined as "those issues that address the societal and humanistic effect of information, computer, and related technologies."[30] There is relatively little supporting material that would engage students in considering the ethical dimensions of broader issues of technology policy, such as whether there should be legal limits on the use of particular technologies, or how much the financial interests of corporations determine the nation's technology agenda.

In 2000 dozens of respected authorities on education, child development, children's health, and technology called for an immediate moratorium on the further introduction of computers in elementary education, except for children with certain disabilities.

The ISTE standards call for students, by the end of high school, to analyze the advantages and disadvantages of widespread use and reliance on computers and related technologies and to make "informed choices *among*" (emphasis added) technologies. The standards thus implicitly limit the range of choices that both teachers and students can make about computers and related technologies. They can choose "among" such technologies, but not between using them or not using them.

The standards also implicitly encourage both teachers and students to see themselves as dependent on computers for teaching and learning across the curriculum. They require teachers to try to teach children, from very young ages, "positive attitudes" toward advanced electronic uses that

What is most troubling in the ISTE standards is not what they say but what they don't say.

"support lifelong learning, collaboration, personal pursuits, and productivity."

ISTE calls for "developmentally appropriate" uses of advanced electronic media in the classroom. But the relationship between specific standards and children's well-established developmental needs is not apparent, nor are there any research references to support those standards.

This is perhaps the most serious omission in the ISTE standards. A large body of uncontested research on the healthy essentials of childhood stresses the importance of face-to-face relationships in childhood, creative play, and physically active, hands-on lessons of all kinds. ISTE's publications do make some references to the need to pay attention to the developmental level of difficulty of classroom activities involving advanced technologies. And many of its recommended classroom activities do incorporate some hands-on aspect into projects along with the use of advanced electronics. Yet ISTE's overall message is clear: advanced technologies are a critical element of education and need to be integrated from the earliest years through high school.

Overall, the standards present a one-sided and very positive view of advanced technologies in education. They leave little room for broader considerations. "The standards are presented as 'there are no questions, there are only answers,' " said Heather-Jane Robertson, the former director of professional development for the Canadian Teachers Federation, who reviewed the standards in the September 2003 issue of *The Journal of Teacher Education*.[31]

The new ISTE standards for education administrators illustrate the same narrow perspective. Administrators are charged with forging a "shared vision" that endorses ISTE's point of view. Success in attaining this shared vision, ISTE officials have explained elsewhere, "means that the commitment to technology is systemic. From the state education department to school administrators to the school grounds personnel, there is an understanding of, commitment to, and sense of advocacy for the implementation of technology."[32] By implication, then, there is one correct vision: ISTE's. Success is measured by how well one promotes ISTE's goals.

The fundamental flaw in the ISTE standards is their unquestioned assumption that computer technology must be integrated across the curriculum and at every level of schooling, despite the lack of compelling evidence for such policies. Many informed observers have concluded that "computers can be a waste of time and energy much more easily than they can be useful," says Greg Pearson, staff director for the National Academy of Engineering's 2002 report *Technically Speaking: Why All Americans Need to Know More About Technology*. But the ISTE standards make no mention of the ongoing debate about the effectiveness of computers in education.

ISTE's standards assume that the only way to develop technology literacy is to immerse children in a "technology-enhanced" learning environment from the age of three or four.

The standards' recurring call for "student-centered" learning is ironic. In these standards, students are not free to choose not to use high-tech tools. It would be more accurate to describe what the standards actually impose as technology-centered learning.

ISTE refers a number of times in its publications to the "national consensus" that its standards repre-

sent. Yet in creating its standards and supporting material ISTE did not draw on a broad range of child development experts. Instead, it appears to have relied mainly on proponents of educational technology.

For example, ISTE and its partners solicited the names of teachers, teacher educators, and curriculum and technology coordinators who were "deemed exemplary in the eyes of their peers in their ability to integrate the use of technology to support teaching and learning."[33] The NETS leadership team, which included a representative from Apple, a major funder of the effort, then selected from that group a smaller number to write sample lessons to show teachers how to implement the standards. Intel Corporation paid for publication of ISTE's national standards for teachers in 2000.

ISTE is not the only professional organization to develop technology education standards. The International Technology Education Association (ITEA) issued standards for students' technology literacy in 2000. Developed with help from the National Academy of Engineering, the ITEA standards explicitly encompass the full range of technologies—low- as well as high-tech—and repeatedly emphasize the need for balance in teaching children about the potential for technologies to have both positive and negative social and ecological effects.[34]

The recent call by the National Academy of Engineering for a broader educational focus to help children think critically about technology[35] complements ITEA's standards. NAE defines "technology" far more broadly than ISTE, encompassing a wide range of human inventions and technical skills. It also recognizes the urgent need for teaching critical thinking about technology to prepare citizens to take part in the daunting technological choices before us. Like NAE, ITEA's wider view of technology literacy goes well beyond what most people mean when they say "computer literacy."

But ISTE has been far more active in advocating for its standards at state and national levels.

Profitable Connections

As the NETS standards project has unfolded, a complex web of financial and political connections has developed that links ISTE, CoSN, their corporate members, and other school technology vendors to each other and to federal, state, and local education officials. Some examples of these connections:

The "ISTE 100." ISTE has increasingly turned to the business of marketing new products and services based on its success in interesting federal and state officials in its standards. Today ISTE has an expanding line of publications and services, most linked in some way to the success of its standards project. It sells corporate memberships for $5,000. About 50 have joined the "ISTE 100," as a group of "select, forward thinking corporations." It appears, however, that paying the membership fee is the basic criterion for selection. ISTE itself advertises the ways that it provides access for its corporate members to the state, district, and school officials who are charged with deciding which high-tech products to buy in bulk.

ISTE provides each company with its own "ISTE 100 representative," who helps the company "build and implement your plan of action for involvement with ISTE." It offers companies access to its special advocacy group of educators, who have volunteered to be "survey respondents, beta testers, focus group participants, and more"[36] for corporate members. Two slots on its board of directors are reserved for corporate members. David S. Byer, Apple's executive in charge of advocacy and strategic relations related to education, is currently one of the two corporate representatives on the board and also serves on its six-person executive board.

Paying for ISTE's stamp of approval. ISTE also has limited the opportunity for companies to have their products considered for ISTE's stamp of approval (signifying alignment with the ISTE standards) to its own fee-paying members. ISTE charges $1,000 for an initial review of a product and a graduated set of fees for every level of approval a product earns. ISTE then negotiates with a company over how much it will charge for a temporary license allowing the company to advertise its ISTE link—the "ISTE NETS Seal of Alignment." Renewing the licenses, which in several cases are set to expire after just one year, involves additional fees. If ISTE is especially enthusiastic about a product, it seeks to partner with the company in producing and selling that product.

Three corporate members helped ISTE design this program: Microsoft, Intel, and PBS TeacherLine. A Microsoft product and an Intel service were among the first few awarded the ISTE seal. PBS TeacherLine is the first corporate member ISTE has decided to actually partner with. The two will collaborate in developing an online certificate program for teachers to demonstrate that they have met ISTE's standards for teacher proficiency in using technology.

Tapping into the testing market. ISTE also has now joined forces with the Educational Testing Service (ETS) to develop, promote, and market a line of assessments and professional development services for what they call "ICT literacy," for information and communication technology. For ETS, this is part of a broader global plan to develop and promote international technology literacy standards and then offer countries around the world a chance to buy a full array of assessment products and services that can be used to implement their standards.[37]

Testing for tech literacy with Microsoft products. In June 2004, ISTE announced that it was teaming up with Microsoft to offer free online assessments of technology literacy for middle schoolers. The assessments are aligned with ISTE's standards and are to be used to help schools show that eighth-graders are technology literate, as the federal NCLB Act requires.

Microsoft has selected ISTE to be a major player in its new U.S. Partners in Learning Initiative, which is a $35-million five-year effort to develop "sustainable" models for combining teaching and technology. This test is its first result.[38]

Federal grant helps companies. The Partnership for 21st century Skills is another business-education hybrid that has promoted spending on high-tech classrooms and, like ISTE, has received Education Department support. Under its federal grant, this new group has worked to define, promote, and figure out how to assess the skills that students will need in the new century. Founded in 2002, it has just eight members—seven high-tech companies or company foundations and the National Education Association. So far, it has been chaired by one of the business-affiliated members, which recently included the AOL-Time Warner Foundation, Apple, Cable in the Classroom, Cisco Systems, Dell Computer, Microsoft, and SAP America. Its day-to-day management and research operations are handled by two ed-tech consulting firms.

The partnership reported in June 2004[39] that there is a "broad consensus" among educators, business leaders, policymakers, and the public that the best educational model is one that embeds ICT literacy and the related "21st century tools" into the standards, curricula, and assessments for core subjects in schools.

For $5,000, a meeting with state officials. The State Educational Technology Directors Association (SETDA) was founded in 2001, the year Congress completed work on the No Child Left Behind Act. SETDA's goal is "to improve student achievement through technology" and it

works in partnership with the Education Department, education associations, and companies, according to its web site.[40] SETDA's founding partners included ISTE and CoSN, as well as two other ed-tech groups and the Council of Chief State School Officers. Its members include the top educational technology officials from state departments of education and members of their staffs. The group allows these top state officials to network and to work together on ed-tech issues of mutual interest and concern. It also helps high-tech companies network with them—for fees that depend on the amount of access a company wants.

"Platinum" SETDA sponsors pay a fee of $25,000 a year. Among the benefits they receive is an opportunity to take part in the group's annual Emerging Technology Forum "at no additional charge." That includes "a one-hour session where a company representative presents your newest products to at least five state directors to gain insight, feedback, and suggestions for enhancing its effectiveness in the K-12 market." Platinum sponsors recently included Apple, Blackboard, Inc., Gateway, IBM, Microsoft, Pearson Education Technology, Surf Control, and Texas Instruments. Each platinum member can also send a representative to the otherwise closed work sessions at the group's annual National Leadership Institute.

"Gold" sponsors pay $10,000 a year. They too can attend the forum and arrange an hour session with at least five state directors, but they have to pay another $5,000 for it. SETDA elsewhere announces to its members that it "is pleased to provide travel reimbursement (up to $1,000)" for each state to take part in the forum. But it also reminds state employees that they must participate in a certain number of meetings with SETDA corporate sponsors and other approved vendors to qualify for the reimbursement. The forum in 2004 was in New Orleans, to piggyback off ISTE's annual National Educational Computing Conference—known for showcasing the world's largest exhibit of high-tech products for schools.

There is no supporting evidence in the ISTE standards for the underlying assumption that young children will benefit from using computers.

SETDA's online promotions also assure businesses that it can "guarantee attendance of at least 100 state level ed-tech leaders" at its leadership institutes because SETDA reimburses their travel expenses "to eliminate the barrier of travel cost." It also reminds them how influential its members are, at the local, state, and national level. "By supporting SETDA," the association emphasizes, "your company is supporting the growth of educational technology."

SETDA's fee-based events sound a lot like the "MarketMaker" events sponsored by the Software & Information Industry Association. Those bring companies interested in selling together with companies interested in buying and charge the interested vendors a fee for brokering the rendezvous. Vendors who are not members of the SIIA pay $495 for the first "MarketMaker" meeting with a potential customer, and $350 for each additional meeting. If vendors are members, however, they pay just $295 for the first customer meeting, and just $95 for each additional one.[41]

The similarity may not be a coincidence. Melinda George, the executive director of SETDA, was formerly the director of SIIA's Education Market Division and before that worked in government affairs for the software association.

Building brand loyalty in K-12. The SIIA education division prepared its 2001 Education Market Report: K-12, with its theme of "Understanding the Education Market," partly under George's direction before she left to lead SETDA. Its executive summary describes why education—especially K-12 education—is such an attractive high-tech market: "As the second largest market in the U.S., education continues to draw attention," the summary states. "The K-12 segment of the market is especially attractive for its size, both in terms of population and expenditures. It also has the potential for establishing identity and long-term brand loyalty among various consumers…. Whether you are analyzing the market for potential investment, building a business plan, looking to expand your market penetration, conducting strategic planning or simply looking to maximize education market revenues, this report will have insightful information to assist your analysis."

A corporate boost to grassroots advocacy for federal funding. The Washington firm of Leslie Harris & Associates has represented ISTE, CoSN, SETDA, the National Education Association, the National School Boards Association, and such high-tech companies as America Online, Cox Communications, IBM Global Education, Intel, Time Warner, and Verizon. The firm has taken credit for helping to shape the multi-billion-dollar E-Rate program that provides federal discounts to schools and libraries for online connections as well as the ed-tech provisions in No Child Left Behind. It is known, it claims, as "one of the most effective firms shaping educational technology policy and helping schools and technology companies make the most of federal ed-tech resources."[42]

In 2004, ISTE and CoSN teamed up to further strengthen their grassroots advocacy network in the face of potential cuts to federal ed-tech budgets. Leslie Harris herself provided free training for educators and others taking part in ISTE's and CoSN's joint annual Washington Advocacy Day in March 2004. Their visits to their respective Congressional offices were pre-arranged for them.

Critical Thinking About the Potential for Bias

The picture that emerges from the financial and political relationships between education officials at every level of government, major companies marketing high-tech products to schools, and ISTE, an organization which itself includes major vendors selling to schools, is disturbing. It appears that public officials have both encouraged and at times helped finance a leading role for school technology vendors to help shape and promote national standards that support a strong market for their products—funded from the limited resources of public education—in perpetuity.

The individual members of ISTE's standards panels are no doubt sincere in their enthusiasm for high-tech products for students of all ages. But the correspondence between the marketing interests of high-tech companies and the public agenda they promote is striking. Citizens need to be alert to the increasing influence of corporations in public policy on education. Meanwhile, many major education associations appear to have fallen in line to cooperate with the effort, and parents, educators, policymakers, and the press have raised few questions about the obvious potential for bias—whether intended or not—in public policies. Could there be a more powerful example of why we need to educate our children about technology in new and more critical ways?

"The marketing blends directly into the ISTE standards," says Heather-Jane Robertson, author of *No More Books, No More Teachers*. "How docile we all are in the face of all this."[43]

The Alliance for Childhood is deeply concerned about the active collaboration between government education agencies and the high-tech corporate world. Even if all are sincere in thinking that

technology is essential in education, the strength of their convictions is not supported by research or classroom experience. Yet parents, teachers, and child development experts who are concerned feel helpless in the face of the financial might of these organizations and their savvy in promoting their point of view. One essential role of government agencies is to check the excesses of the business world. Instead the agendas of public officials at all levels are so similar to those of high-tech businesses that there is no discernible difference between them.

The lack of evidence or an expert consensus that computers will improve student achievement—despite years of efforts by high-tech companies and government agencies to demonstrate otherwise—is itself compelling evidence of the need for change. It's time to scrap the ISTE standards and all other national, state, and local policies that require all students and all teachers to use computers in every grade, and that eliminate even the possibility of alternatives.

To expect our teachers, our schools, and our nation to strive to educate all of our children, leaving none behind, is a worthy goal. To insist that they must at the same time spend huge amounts of money and time trying to integrate unproven classroom technologies into their teaching, across the curriculum with preschoolers on up, is an unwise and costly diversion from that goal. It comes at the expense of our neediest children and schools, for whom the goal is most distant. For that reason, we urge parents, educators, and policymakers to take a fresh look at current technology education standards.

References

1 See Title II, Part D of P.L. 107-110, Enhancing Education Through Technology, posted on the Education Department's web site at www.ed.gov/policy/elsec/leg/esea02/pg34.html, last accessed Aug. 30, 2004. It authorizes up to $1 billion a year for fiscal years 2002 through 2007 for states to distribute locally for educational technology, and requires state education agencies to have long-range educational technology plans that specify how they will use the money to improve the academic achievement, "including technology literacy," of "all students" and to help "all teachers" to "integrate technology effectively into curricula and instruction." It also requires them to describe steps to make sure that "all students and teachers" have increased access to educational technology and their timelines for integrating technology "including software and other electronically delivered learning materials" into curricula and instruction. Local districts that receive money under the program must have similar long-range plans.

The law also calls for all students to be "technologically literate" by the time they finish eighth grade—although it allows each state to define technology literacy for itself. Guidelines also require state and local plans to describe how they will fully integrate technology into curricula and instruction by the end of 2006. They also must measure how effective they have been in spending the money to improve teaching and to increase student academic performance.

The law instructs the education secretary to describe how he will collaborate with other federal agencies to "promote the use of technology in education." In response, the U.S. Department of Education has signaled that its updated national educational technology plan, expected to be out by the end of September 2004, will focus on three priorities: the management of student data, online assessment, and "eLearning," a term that seems to include distance education, "virtual" schools, and online tutoring.

The law does not define technology, but it is broadly assumed to be referring to digital and other new electronic technologies.

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3 Ellen R. Delisio, "Technology Integration, Assessment, and No Child Left Behind," *Education World*, April 30, 2003 (www.education-world.com/a_tech/tech171.shtml, last accessed Aug. 29, 2004). The Education Department makes the same point in an online slide presentation posted on the agency's web site.

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8 "Personalization and Empowerment: No Child Left Behind and Technology," CoSN's 9th annual K-12 School Networking Conference, March 2-3, 2004.

9 Glenn M. Kleiman, "Does Technology Enhance Inquiry-Based Learning?" *What Does the Research Say?* vol. 1 (www.cosn.org/resources/edc/vol_1.cfm, last accessed Aug. 27, 2004.)

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12 U.S. National Science Board, "Children, Computers, and Cyberspace," Science and Engineering Indicators, Washington, D.C., 1998. This report stated: "The fundamental dilemma of computer-based instruction and other IT-based educational technologies is that their cost effectiveness compared to other forms of instruction—for example, smaller class sizes, self-paced learning, peer teaching, small group learning, innovative curricula, and in-class tutors—has never been proven."

13 Hersh C. Waxman, Michael L. Connell, and Jon Gray, "A Quantitative Synthesis of Recent Research on the Effects of Teaching and Learning with Technology on Student Outcomes," North Central Regional Educational Laboratory, Dec. 2002.

14 Robert F. Murphy, William R. Penuel, Barbara Means, et al., "E-DESK: A Review of Recent Evidence on the Effectiveness of Discrete Educational Software," SRI International, April 2002. Prepared for the Planning and Evaluation Service, U.S. Department of Education, DHHS Contract # 282-00-008-Task 3.

15 "Out of the 195 experimental or quasi-experimental evaluation studies that our initial search identified, just 31 studies used designs that met our minimum requirements for methodological criteria: the use of a comparison group, large enough samples, reliable measures of achievement, and sufficient information for estimating an effect size. These criteria are considered by research methodologists to be standard features of rigorous quantitative research. A majority of the studies were excluded because they failed to use an adequate comparison group or omitted important data that would allow for the calculation of an effect size." (Murphy et al., op. cit., p. 73.)

The study made no suggestion of the direction of bias. But it seems likely that vendors would be less likely to report negative research results. Likewise, the first meta-analysis cited above (Waxman et al.) noted: "There is evidence that many Web-based technical reports are sponsored by agencies that have obvious conflicts of interests associated with the results," and gave as a common example school districts that hire researchers to evaluate the district's own programs.

16 "Because of the small number of studies, the fundamental flaws in some of their designs (e.g., small sample sizes, non-equivalent treatment and control groups, differential attrition among treatment and controls), and the lack of information describing the details of research designs, the ability to generalize from these results is limited…. Although the magnitude of these associations is consistent with those in prior research reviews, the small number of studies in our review and their methodological flaws do not allow us to rule out the possibility that factors other than the use of the DES [discrete educational software] products were responsible for the positive associations" (Murphy et al., op. cit., p. 74).

17 See Chapter 6 for more on the healthy essentials.

18 See, for example, Larry Cuban, *Oversold and Underused: Computers in the Classroom*, Cambridge: Harvard University Press, 2001, and Oppenheimer, op. cit. Cuban is a former president of the American Educational Research Association. Oppenheimer won the 1998 National Magazine Award for his *Atlantic Monthly* article on this subject.

19 ISTE's sets of standards and supporting documents can be found at http://cnets.iste.org.

20 International Society for Technology in Education, *National Educational Technology Standards for Students*, published in collaboration with the Milken Exchange, June 1998.

21 The Milken Exchange was a program of the Milken Family Foundation, founded by Michael and Lowell Milken. Both are also co-founders and chairman and vice-chairman, respectively, of Knowledge Universe, the parent of Knowledge Universe Learning Group. The learning group includes educational ventures with a heavy technology focus, including LeapFrog, which sells high-tech products to accelerate learning for infants, toddlers, and older children. Knowledge Universe Learning Group also invested $10 million to help start up K12, Inc., the largely online schooling business that William Bennett, the former education secretary, helped found and which he serves as board chairman. Current Secretary of Education Rod Paige was a member of

the K12 board in 2000, when he was nominated for his current post. Lowell Milken was also listed as a member of K12's board on its web site, www.k12.com, as of Sept. 6, 2004.

22 SIIA describes its mission as promoting, protecting, and informing the software and digital content industry. (www.siia.net/membership/overview.asp, last accessed Sept. 2004.)

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24 *National Educational Technology Standards for Teachers*, International Society for Technology in Education, 2000, Performance Indicator No. II A.

25 Ibid, p. 3.

26 *National Educational Technology Standards for Students*, op. cit., p. 9.

27 ISTE Teacher Standards, *Resources for Assessment*, p. 35.

28 Ibid, p. 78.

29 Telephone interview with Alan Hedge, Aug. 2004. For fuller discussion, with references, of the risks of visual strain and musculoskeletal issues, see Chapter 2, "Developmental Risks: The Hazards of Computers in Childhood," *Fool's Gold: A Critical Look at Computers in Childhood*, College Park, Md.: Alliance for Childhood, 2000, pp. 20-28 and 40-42.

30 ISTE Teacher Standards, Resources for Assessment, p. 218.

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38 From "ISTE News: ISTE and Microsoft Team Up to Provide Online Assessments of Technology Literacy in Middle Schoolers," Washington, D.C.: ISTE, June 17, 2004.

39 See www.21stcenturyskills.org (last accessed Aug. 2004).

40 See www.setda.org (last accessed Aug. 29, 2004).

41 "SIIA MarketMaker: Brokering Relationships for the Enterprise IT Economy," SIIA. (www.siia.net/marketmaker/vendors.asp, last accessed Sept. 2004).

42 See the web site of Leslie Harris & Associates, www.lharris.com. The quoted passage is at www.lharris.com/portfolio/index.html (as of Aug. 27, 2004).

43 Telephone interview with Heather-Jane Robertson, Feb. 2004.

Chapter 4
Ten Principles for a New Literacy of Technology

This is the crucial starting point in setting the criteria for a child's relationship to technology: determining what activities lead to the full development of a child's human capacities. That concern lies at the very heart of the Alliance for Childhood's technology literacy guidelines.

Child Development Principles Should Guide Technology Learning

To say that we must educate our youth about weighty technological issues is not enough. We need to pay close attention to how it is done. Most critically, it requires knowledge of children's developmental needs. Many current technology literacy programs pay lip service to "developmentally appropriate" activities, but nearly all of these seem guided more by what children *can* do with computer-based tools than by a deep understanding of what children *need* to help their intellectual and emotional lives unfold and thrive. Technology education should be guided not by a focus on tools but rather by the activities that help children develop their full capacities. This, in turn, will govern what tools they should use at different ages.

This flies in the face of current efforts to so integrate high technology into the classroom that it becomes "invisible." Our conception of technology literacy would do just the opposite—bring the technology, along with the thinking that lies behind it, into full visibility so that it can be closely exam-

Current technology literacy programs tend to equate technology with electronics and thus fail to promote the important benefits that come from using low-tech tools.

ined, critiqued, and contextualized. Education is, at its heart, a process of unveiling the world. To give our children tools that are shrouded in a darkness the children cannot penetrate is absurd. To transform those "black boxes" into invisible ones merely places them further beyond the curiosity of children, beyond even the knowledge that there is something to be curious about.

To base a technology literacy program on the developmental needs of children is to recognize that, in general, there should be a close match between the complexity of the tools children use and their capacity to understand how those tools work. The consequences of adopting this approach are significant (and controversial). It implies a restructuring of the resources used throughout the curriculum at all levels of learning. It would likely mean that televisions, computers, and tape recorders would vanish from most elementary classrooms, replaced by simpler means of expression and impression.

Would children's learning suffer as a result? To date, the evidence indicates it would not.[1] The ultimate answer to that question would depend on the imaginative creativity of the teacher herself. In fact, the lack of sophisticated electronic equipment at the lower grades would encourage good teachers to develop their own talents and community resources, which would be a valuable *addition* to most learning environments. For example, if fourth-grade students are unable to vicariously experience biking through the Rift Valley of Kenya via the internet, they might instead get to discuss with Somali or Ethiopian refugees living near their own communities what life was like before leaving Africa. If teachers do not use sing-along tapes in the lower grades, there should be plenty of redirected tech support funds available to train them to play simple instruments (and even buy those instruments) for classroom use. In general, teachers might find it more difficult to lead their students to information that isn't tied to their own experience. But those teachers also might discover that the unexamined mantra of instructional technology, that the teacher should be "the guide on the side," unfairly diminishes their importance; that, as Stephen Talbott has pointed out, what really matters in the lower grades is not the information the child accumulates: "What counts is from whom she receives it. The respect and reverence with which a subject is treated, the human gestures with which it is conveyed, the inner significance the material carries for the teacher—these are infinitely more important to the child than any bare, informational content."[2]

This reassertion of the primacy of the teacher in the learning process is a key element in any technology literacy program, for it mirrors the primacy of humans in our relationship to tools. It establishes at the structural level of education our intentions to be the judges of technologies, not to be judged by our facility with them.

This is the crucial starting point in setting the criteria for a child's relationship to technology: determining what activities lead to the full development of a child's *human* capacities. That concern lies at the very heart of the Alliance for Childhood's technology literacy guidelines.

For elementary school children and preschoolers, the use of any technology should be determined by its ability to support and deepen what we consider to be the healthy essentials[3] of childhood.

These healthy essentials include:

- Close, loving relationships with responsible adults, at home and at school.
- Direct knowledge of the living world of nature, developed through outdoor play, exploration, gardening, and other encounters.
- Time every day for child-initiated play.
- Music, drama, puppetry, dance, painting, and the other arts, offered both as separate classes and as a kind of yeast to bring the full range of other academic subjects to life.
- Hands-on lessons, handcrafts, and other physically engaging activities, which literally embody the most effective first lessons for young children in the sciences, mathematics, and technology.
- Rich face-to-face language experiences, including conversation, poetry, storytelling, and books read aloud with beloved adults.
- Time and space for children to create meaning and experience a sense of the sacred.

Some who read this list might complain that there is no place for the use of technology. That is true only if the concept of technology is radically narrowed to electronic high technology. A broader and more complete conceptualization of technology, one that encompasses all tool use, reveals that, indeed, there is a strong relationship between healthy development and using tools. Gardening, puppetry, painting, music, handcrafts, and reading all rely on skillful use of tools. Hands-on lessons directly implicate the importance of a variety of tool uses by children.

Unfortunately, current technology literacy programs tend to equate technology with electronics and thus fail to promote the important benefits that come from using low-tech tools like hammers, shovels, ropes, paper, and crayons. A new technology literacy that operates out of concern for children's needs recognizes the full range of technical activities available and necessary for healthy growth.

The Wisdom of Timing in Technology Education

A second part of this developmental concern is timing. Our culture has long recognized the need to withhold many tools (sharp instruments, automobiles, guns) from children until they can handle them safely and responsibly. Similarly, just because some ten-year-olds may be able to read all of the words in a Shakespeare play, we don't make them read *King Lear*. We expose fourth-graders to ennobling stories like *Charlotte's Web* and reserve darker works like Kafka's *The Trial* for a much later time.

The same judgment is needed in exposing children to mental tools, based not just on the content but also on the character of those tools. There is no obvious path to follow here. Whereas the dangers posed by physical tools are usually clear because they exist in the physical realm, the dangers of mental tools for youth are not directly or immediately observable. Nevertheless, they are real.[4]

There is always a potential conflict between using tools, which extend human powers outward, and healthy child development, which is most critically concerned with increasing the inner capacities of the child. A microphone, for example, both amplifies a child's voice and removes the necessity of developing her own ability to project her voice. Today's youth are both the most mobile in history and probably the least physically fit, thanks in part to a variety of energy-saving transportation and communication technologies. In our schools, word processors have made it possible for children to hand in long essays with no spelling errors, while they are themselves barely able to spell. All of these examples illustrate Marshall McLuhan's assertion that all technologies both amplify and amputate.

This is particularly true for children, who are in the process of developing all kinds of inner capacities. Current technology-literacy programs pay little or no attention to the dangers of technological amputation. To ignore that technologies can substitute as well as extend human powers is to ignore the fact that humans are not born fully developed. It paves the way to accept external power as a substitute for internal growth. But it is only internal growth that generates the maturity necessary to give moral and ethical direction to the use of those powerful tools.

We must both teach young people to recognize those dangers and help adults figure out how best to time the availability of powerful tools to children.

As children grow, their needs and capacities change. Certainly, technology literacy will involve learning how to skillfully and responsibly operate a variety of more complex tools. But that isn't all. Technology literacy requires at least four other skills:

1. A rudimentary understanding of how at least a few fundamental technologies work, including their underlying principles.
2. A capacity to think critically and creatively, for one's self, about the design, use, and evaluation of technologies to serve personal, social, and ecological goals.
3. Love and concern for all living creatures that directs decision-making about technological issues.
4. A sense of responsibility for actively taking part in democratic choices about technologies.

These concerns taken together have led the Alliance for Childhood to redefine technology literacy as follows: Technology literacy is the mature capacity to participate creatively, critically, and responsibly in making technological choices that serve democracy, ecological sustainability, and a just society.

To be technologically literate requires that we judge technology's impact on our lives according to some set of values that transcend mere technical virtuosity. It requires a commitment to strive to understand the relationship between technological change and democratic values, of how technologies serve and threaten social justice, and of the ways in which technical innovations affect the prospects for life, both human and nonhuman, on this planet.

In paying attention to these values in our schools we establish technology within the sphere of political discourse, a matter to be studied and addressed democratically, not solely by experts immune from public oversight.

These concerns, filtered and shaped to fit the understanding of children of varying capacities, should drive any technology literacy program. The great challenge for educators and parents is to match the unfolding of a child's capacities and internal powers with an appropriate unfolding of the child's access to and understanding of the tools that extend those powers.

How to do that, while gradually bringing children to an understanding of how various tools actually work, is precisely the task schools should take up as part of their core K-12 curriculum. Ideally, this is local ground to be broken in each school district. From the impact of rural electrification to the loss of antibiotic effectiveness in local hospitals to the connection between home schooling and internet access, a wide variety of first-hand concerns could be used to help students understand the effect technology has on their communities.[5] This document is an attempt, perhaps for the first time, to guide educators and parents who wish to undertake that task.

Ten Principles for a New Literacy of Technology

Based on the goals and priorities outlined above, we offer ten principles for teaching this new literacy of technology *(See Figure 1)*.

Figure 1

Ten Principles for a New Literacy of Technology

1. Slow down: honor the developmental needs of children.
2. With adolescents, teach technology as social ethics in action, with technical skills in a supporting role.
3. Relationships with the real world come first.
4. Technology is not destiny; its design and use flow from human choices.
5. Choice implies limits—and the option to say "no."
6. Those affected by technological choices deserve a voice in making them.
7. Use tools and technologies with mindfulness.
8. To teach technology literacy, become technologically literate.
9. Honor the precautionary principle: When uncertain, err on the side of caution.
   - Ask tough questions about long-term consequences.
   - Make time, space, and silence for reflection.
   - Responsibility grows from humility.
   - Be resourceful with the tools you already have.
10. Respect the sacredness of life in all its diversity.

In the next two chapters we offer real-life examples of how each principle can be put in practice and developmental guidelines to apply them in the different phases of childhood and adolescence. Our intention is to help educators and parents develop their own programs of technology literacy. Given that a young person's relationship with technology changes over time, no simple set of guidelines can serve all ages.

Please keep in mind our premise that a healthy relationship with technology grows out of the context of a healthy relationship with the world. Thus, some of the principles and examples do not refer to any actual contact with advanced technology, especially at the younger ages. They refer, instead, to activities that establish the deep roots of the inner and social life needed to give direction to the subsequent use and understanding of technology.

Technology literacy depends on more than the skills and dispositions people take away from their encounters with tools. It depends on the skills and dispositions that people bring to those encounters. A technology literacy program for youth pays close attention to the full range of activities and relationships children participate in, not just those in which advanced technologies are an obvious part. This approach should help young people avoid the aura of inevitability that surrounds technological change in our society, endowing them with the sense of freedom and dignity that comes from being able to direct technological change, not just react to it.

References

1 Larry Cuban, *Oversold and Underused: Computers in the Classroom*, Cambridge: Harvard University Press, 2001.

2 Stephen L. Talbott, *The Future Does Not Compute: Transcending the Machines in Our Midst*, Sebastopol, Calif.: O'Reilly & Associates., 1995, p. 171.

3 For more discussion of these healthy essentials, see Chapter 6.

4 For a complete discussion of the dangers of computer use by children, see *Fool's Gold: A Critical Look at Computers in Childhood* (Alliance for Childhood, 2000), and Chapter 2 of this report. For a comprehensive annotated bibliography addressing the character of computers and technology in general, see the Confronting Technology web site, www.gemair.com/~lmonke/.

5 In fact, those issues are just the kinds of things students could research as part of their literacy studies. Those studies could also be incorporated into the students' other work, much as multicultural studies have been integrated.

Elementary students reading a popular book like *Hatchet* could discuss and write about why Brian felt uneasy about using the rifle he eventually recovered to aid his hunting instead of the bow and arrow he had fashioned when first marooned. In middle schools, students studying energy in science and our dependence on oil in social studies could investigate energy consumption in their own buildings and develop conservation and alternative energy ideas. In high schools, students in a variety of classes could work together to actually build alternative energy sources that make sense for their locale.

Chapter 5
The Ten Principles in Action

The old model of curiosity-driven science and profit-driven or war-driven technical advances is obsolete. A real commitment to social responsibility in the United States—in education, science, and engineering—could touch off a century of social innovation. Focusing on the possibilities for human beings to voluntarily change their behaviors could ultimately prove far more effective in promoting peace, justice, and healthy ecosystems than our current national fixation with an endless round of technical innovations.

The Alliance for Childhood believes that technology literacy must be homegrown. Though we offer examples below and some key insights for teaching children about technology, the work of curriculum development and home learning is left to educators and parents who know their children best.

We hope that the ten principles introduced in Chapter 4 and the developmental guidelines in Chapter 6 that are derived from them will inspire and support that important work in communities all over the world. We explain the principles more fully here and illustrate, from actual programs and practices, the range of possibilities that exist if we are serious about helping children apply creativity, critical thinking, and social responsibility in relating to technologies. We include these examples to inspire others with ideas and resources for creating meaningful new opportunities to teach students about technology as social ethics in action. (Additional examples will be posted on the Alliance's web site: www.allianceforchildhood.org.)

PRINCIPLE 1:
SLOW DOWN: HONOR THE DEVELOPMENTAL NEEDS OF CHILDREN.

Children under age 16 should be discouraged from spending large amounts of time using advanced technologies and from operating them without adult supervision. This includes television, instant messaging and other online communications, internet surfing, video games, and cell phones. We recommend a very gradual introduction to the operation of electronic and other advanced technologies, with attentive adults providing close guidance, time limits, and strong examples of how to set limits.

We recognize that most children in the United States today are using computers, video games, cell phones, the internet, and handheld electronics. We realize that following strictly the advice we offer here would require a dramatic turnaround for many schools and families. Still, we have found compelling evidence that the current high-tech culture of childhood poorly serves children's healthy development.

Most states require that residents be at least 16 before they obtain a license to drive a motor vehicle, and that they first demonstrate that they have both the knowledge and skills to do so without harming themselves or others. Computers, in their own way, are as powerful as the family car. Speeding along the "information superhighway" poses real dangers for youngsters. The solo use of electronic media by children and teens today often involves a barrage of violence, aggressive marketing of junk food, trivial data and misinformation, misogyny, and pornography.

For an increasing number of socially challenged adolescents, especially boys, the electronic world becomes an escape from relationships with peers or a narrowing of such relationships to the safety of video-game or screen-based interactions. Social scientists and mental health experts continue to debate the effect of the proliferation of electronic interactions on human relationships and civic engagement. But a plethora of anecdotal reports from middle-school principals and parents suggests that a significant minority of young adolescents are literally screening out the social and emotional challenges of adolescence.

We hope that parents, teachers, and school administrators will seriously consider the guidelines we propose in Chapter 6 based on this principle and will adopt, adapt, or reject them based on their own best thinking about what will be healthiest for children. This will require putting aside the intense commercial pressures to divert limited public dollars and family income to expensive high-tech products that are unnecessary and potentially detrimental for children. That pressure stems from the mistaken assumption—and its aggressive marketing—that earlier is always better for exposure to advanced technology.

At first glance, our proposals may sound hopelessly out of touch with reality. But given the rapid obsolescence of most electronic products, a gradual movement towards these goals could be easily and cheaply achieved. It is likely, however, to leave children and adolescents—and the adults who choose to mentor them—with a good deal more time on their hands. We recommend a new focus on the healthy essentials of childhood (see Chapter 6) for much more creative, enjoyable, and purposeful activities to replace electronic habits that may border on addiction.

Example: The Edible Schoolyard
Berkeley, California

Since 1993, the Martin Luther King, Jr. Middle School in Berkeley has been transforming its schoolyard into an edible garden and enriching its curricula and shared community festivities with the tasty results. With the support of chef Alice Waters, the principal, teachers, community members, and 900 students turned an

abandoned paved lot adjacent to the school into a garden and have since expanded their gardens, rotated crops, and have worked on landscaping the entire campus to create a "school within a garden." They hope to use the garden and the lessons learned to eventually transform their school lunch program.

The old school kitchen was turned into a homey classroom kitchen where lessons combine history, geography, science, literature, and the art of good cooking from around the world. In one lesson, for example, sixth-graders studying India made chapati, *a whole-wheat flat bread, by hand, first grinding wheat berries, mixing dough, and then shaping the bread. Basic concepts of Indian culture, such as wholeness, the sacredness of food, and a minimum of waste emerged naturally from the lesson. This kind of lesson also sparks discussions about the roles of food in different cultures and the impact of climate and terrain on food production.*

Students also regularly work in the organic gardens, and the gardens and kitchen classroom have been the site of family writing nights, Passover seders, family dinners, an African-American family dinner, and Dia de los Muertos, *a traditional Mexican celebration. Children have also done composting, grown medicinal herbs, created wreaths from garden materials, donated vegetables for hungry local residents, and created new school traditions such as grilling fresh ears of corn in the garden for incoming sixth-graders. The plantings have included an orchard with apple, plum, and pear trees, gooseberries, peas, pole beans, blackberries, tomatoes, onions, peppers, basil, broccoli, collard greens, hazelnuts, raspberries, edible bamboo, gourds, mint, and chayote. Students have also prepared grafts from the fruit trees to pass on to other school and community gardens. Excitement about the project led the Berkeley school district to adopt a policy emphasizing organically grown produce in school meal programs. (www.edibleschoolyard.org; 510-558-1335.)*

PRINCIPLE 2:
WITH ADOLESCENTS, TEACH TECHNOLOGY AS SOCIAL ETHICS IN ACTION, WITH TECHNICAL SKILLS IN A SUPPORTING ROLE.

By the time students graduate from high school they should have been offered the opportunity to develop the following:

1. Basic computer skills, including the routine practice of proper ergonomics and observation of time limits in sedentary activities, keyboarding skills, word-processing, rudimentary desktop presentation skills such as the creation of electronic slides, the use of spreadsheets to organize and analyze data, basic internet research skills using search engines, and skill in communicating effectively through e-mail.
2. A clear understanding of ethical uses and abuses of the advanced information technologies they use, such as the internet.
3. At least a rudimentary understanding of the scientific principles underpinning major technologies, such as basic concepts related to electrical, mechanical, fluid, and thermal energy systems. Exploration of these concepts should be studied primarily through hands-on experiences, such as through the construction of a simple computing device.
4. An appreciation for the record of mixed blessings, socially and ecologically, that technological advances have historically entailed.

The actual advanced technology skills required for a technical major in college could be learned in one semester's work. But many high school students do not go on to post-secondary institutions, at least not immediately. So schools should be concentrating their advanced technology spending at the level of senior high school, to guarantee that high-school graduates have the opportunity to learn the technology skills needed for entry-level jobs. This

In our passion for technical innovations, our culture has lost a sense of the much broader possibilities of human creativity.

achievement would go far in closing the "digital divide." The major obstacle to doing so, however, is unnecessary expenditures on inappropriate classroom electronics for much younger children.

By late middle school, students will be doing research for which access to the internet can be a key resource, especially as so many organizations now post a wealth of information there. But the mere availability of such information is no reason to encourage middle-school students to spend hours surfing the web or producing PowerPoint presentations. With reasonable expectations for research assignments, access to the internet in school libraries and help from school librarians in conducting such research seems likely to meet the actual academic needs of most middle-school students.

At both the middle-school and high-school levels, technology education should aim to inspire responsible, civic-minded actions, respect for democratic processes, and willingness to take personal initiative in serving human beings and other living creatures. Responsibility is the ability to be responsive to the real world—to listen, to understand, to appreciate, to serve, to support, to participate. Such responsiveness may be on the wane, as students increasingly are diverted by heavily marketed electronic forms of passive or violent entertainment and bombarded with commercial messages to indulge themselves and "just do it" if it feels good or "just buy it" if it looks cool.

If not guided by a strong sense of social responsibility, scientific curiosity and technological prowess present the potential for great harm, as individuals and small groups of people acquire the skills to deploy weapons of previously unimagined destructiveness. The old model of curiosity-driven science and profit-driven or war-driven technical advances, in other words, is obsolete. A real commitment to social responsibility in the United States—in education, science, and engineering—could touch off a century of social innovation. Focusing on the possibilities for human beings to voluntarily change their behaviors could ultimately prove far more effective in promoting peace, justice, and healthy ecosystems than our current national fixation with an endless round of technical innovations.

Example: Llano Grande Center for Research and Development
Edcouch, Texas

A school and community-based nonprofit at the Edcouch-Elsa High School, 15 miles north of the Texas-Mexico border in the Rio Grande Valley. The center offers students creative projects that weave together opportunities for students to participate in education, research, online and print publishing, video production, the arts, local oral histories, activities and relationships with local elders, community celebrations, and policy action that are focused on pressing social, economic, and environmental issues. The Llano Grande Seminar Series, for example, brings students, teachers, and community members together to discuss issues such as education, the economy, and sustainable development.

As its web site explains, Llano Grande places human relationships front and center in its work, even as it also strives to help high school students apply advanced electronic technologies in the service of community-based projects and encourages them to critically examine the local impact of poverty and social status on the Mexican-American community. Most of the students' parents did not finish high school, but the center

has also successfully mentored dozens of students into some of the nation's leading colleges. It involves students in all phases of its operations—including the creation of material for its web site. It also publishes the Llano Grande Journal, *available online, that includes oral histories from local residents, creative writing, and other contributions from students, teachers, and staff. Students hone their high-tech skills in a richly meaningful context—what the center refers to as a "pedagogy of hope." (www.llanogrande.org; 956-262-4474.)*

Example: Institute for Community Research
Hartford, Connecticut

The Institute works with teachers and students, in and out of schools, to teach urban youth how to apply the research methods and tools of social science, as well as various forms of art, to problems that are directly relevant to students' own lives and communities. For high school students, the institute has also incorporated computer and advanced communications technologies.

The ICR approach emphasizes community-based research for social change, where the community can be the school, the neighborhood, a community organization that welcomes the help of students' researching some question of interest to the organization, or the students' own community of peers. The institute encourages students to take part in identifying the topic they wish to critically examine from their immediate social, political, economic, and cultural environments, and then to apply the results of their studies to some direct action to address the problem in a constructive way. Community-based action research is a flexible enough approach, however, to be relatively easily integrated into middle school and high school curricula. It promotes reading, writing, the principles of science (such as how to develop and test a theory), mathematics, artistic expression, and skills in managing, analyzing, and interpreting information.

For example, the Summer Action Research Training Institute has offered urban youth an intensive six-week exposure to the methods of community-based research and activism, as well as computer software, including cognitive and GIS mapping, statistical analysis, data management, and text data analysis. Topics chosen by the students have included a critical analysis of the impact and incidence of sex at an early age, dropping out of school, factors related to emotional stress in adolescence, exposure to violence, and teen pregnancy.

At the end of the summer program, students have presented their results in a variety of community settings, such as city council meetings, and published them in ways that integrate the arts. ICR has also helped integrate community analysis and risk prevention into high-school science classes, including topics such as suicide ideation and addressing institutional racism. It has also helped middle-school teachers use the methods of social science research to study and create some response of their own to risk-avoidance issues of the students' choice, including running away from home, sexual harassment, and drug prevention. The immediate relevance of these projects to students' lives build science and technical skills in ways that engage hearts as well as minds. They also prepare students to be responsive to the needs of their peers and their communities and to expect to be active participants in democratic social change. (www.incommunityresearch.org; 860-278-2044.) .

PRINCIPLE 3:
RELATIONSHIPS WITH THE REAL WORLD COME FIRST.

The first priority in technology education—as in all education—is to nurture children's relationships with other human beings and with the rest of the living world. This is also the most essential preparation children need for grappling with the daunting social and ecological choices that technology will pose in the 21st century. Young people need to have direct experience of the natural world in all its diversity, messiness, and beauty if they are to appreciate its fragility and irreplaceable value.

Yet this kind of education is becoming increas-

ingly rare. The speed, stimulation, and convenience of new technologies draw adults and children to spend ever more time, at work and play, with an electronic device placed between them and the rest of the living world. That necessarily reduces the time children spend together, face to face, focused primarily on each other. It also creates a culture in which "virtual reality" and relationships with screen images gradually become the norm and are seen as equivalent—if not superior—to the natural world.

Example: Planting the Future
Chicago

Community activists, parent volunteers, and environmental scientists helped more than 400 students, from kindergarten through 8th grade, made their own dream come true by turning a litter-strewn schoolyard in the inner-city neighborhood of Cabrini Green into the only butterfly ecosystem in Illinois. The children were part of a special program run by Community Youth Creative Learning Experience and Science Linkages in the Community (SLIC) at Loyola University of Chicago. This project was part of the larger SLIC program supported by the American Association for the Advancement of Science with an emphasis on hands-on lessons in community settings.

The children, with adult guidance, created a whole ecosystem for butterflies, including tilling the land, planting the flowers and plants that butterflies need to reproduce and grow, nurturing the caterpillars to butterflies, and then enjoying the colorful wonders of the environment they helped to create. As an added boost to science and math learning, the children took field trips to arboretums to learn about butterflies' needs and received related lessons in botany and environmental science. (CYCLE: Community Youth Creative Learning Experience, 312-573-8920, 1111 N. Wells, Suite 300, Chicago, IL 60610. Also, AAAS-(SLIC), 1200 New York Avenue, N.W., Washington, D.C. 20005, 800-351-SLIC; www.aaas.org/ehr/slic.)

PRINCIPLE 4:
TECHNOLOGY IS NOT DESTINY; ITS DESIGN AND USE FLOW FROM HUMAN CHOICES.

The design and uses of technologies are deeply rooted in human choice. These choices always involve issues of ethics and morality. And the more powerful the technology, the more profound are the issues of ethics and morality that students need to be prepared to grapple with as adults. Helping students detect the many layers of choice involved in the pursuit of science and engineering actually invites them to be part of the creative spirit of technological innovation far more than do more common pedagogies that train students to be passive users of high-tech products. Helping students explore how every choice is rooted in an ethical context will graft a new social awareness onto scientific studies and the engineering of new products.

Example: Original Voices

An educational online exhibit that explores the historical human and ecological costs of mining-technology choices in California, beginning with the Gold Rush. Large amounts of mercury were dug up and used in sluice mining, leaving toxic residue at mine sites to this day. Hydraulic technology resulted in huge piles of rock and debris. Sacred sites were destroyed by the use of powerful water cannons, and rivers and creeks were poisoned. Redwoods were destroyed to clear a path for miners, whose stampedes also destroyed indigenous villages in their way.

The exhibit, sponsored by the Ink People Center for the Arts, was designed in 1999 for students at the eighth-grade level and higher. It includes stark historical photographs, accounts of the devastation to the indigenous people's villages and to the land and waters of California of the Gold Rush, biographies, and material on contemporary Native American culture in the state. The exhibit includes suggestions for classroom activities and periodically suggests that teachers break from the online site for live classroom conversations about partic-

ular issues, or time for students to write their own reflections. Such face-to-face interactions and reflection, the exhibit emphasizes, are essential for cross-cultural understanding and real critical thinking.

This alternative history of the California Gold Rush, as seen from the perspective of the culture that was already there, highlights both the negative consequences of the technological choices made and the possibility of making different choices today. (www.originalvoices.org; ova@humboldt1.com.)

PRINCIPLE 5:
CHOICE IMPLIES LIMITS—AND THE OPTION TO SAY "NO."

Our consumer culture inundates young people with messages extolling excess, from super-sized fast-food meals to extreme sports. But preparing students to make conscious choices about technology includes considering how and when to say "no" or "enough." This requires increasingly mature levels of self-discipline, self-awareness, and, eventually, broad social and ecological awareness.

Learning about limits starts with consciously deciding when to turn a computer or television off. It continues with setting other reasonable limits in students' personal lives, and with their participation as citizens in local and national debates about such technology choices as the genetic engineering of food or the environmental costs of the proliferation of sports utility vehicles. Making conscious choices and setting limits related to technologies are likely to be two of the most important skills for 21st century citizens.

Example: Student-Based Citizens Panels on High-Tech Products.

Undergraduates at McMaster University in Hamilton, Ontario, in Canada helped organize a mini-consensus conference in 1998 to explore whether the university should institute mandatory student use of laptop computers. The "lay panel" was made up of students, staff, and faculty members. The "experts" providing the pros and cons of that idea were six other students who had researched the issue for their science, technology, and public policy class. The panel listened to the experts, asked questions, and then deliberated over dinner. It then issued its findings, in terms of what the group could agree to by consensus: McMaster should not make the policy mandatory.

The University of New Hampshire similarly sponsored a consensus conference that included students on a panel of citizens considering issues about genetically modified food. In both of these cases, the students were undergraduates. But the same kind of democratic deliberative process would also engage middle-school and high-school students in thoughtful explorations of home and school use of advanced technologies, such as cell phones. (www.cas.mcmaster.ca/stpp/consensus/laptop/; www.loka.org/pages/panel.htm.)

Learning about limits starts with consciously deciding when to turn a computer or television off.

PRINCIPLE 6:
THOSE AFFECTED BY TECHNOLOGICAL CHOICES DESERVE A VOICE IN MAKING THEM.

Thomas Jefferson believed that education would be the glue of American democracy, enabling citizens to participate in public debate about the most important issues facing the country. In the 21st century, it is clear that the design and use of new and emerging technologies in communications, energy, mass-media advertising and marketing,

genetics, nanotechnology, and robotics will have profound effects on our culture and environment.

Science and technology should be accountable to the people whose lives are affected by them. The strength of our democracy depends on citizens' participation in choices that matter for the future of social and civic life. The brunt of the social and ecological costs of technology—hazardous waste, for example—have frequently been borne by those with the least political and economic power.

Example: The Earth Crew Youth Leadership Program of West Harlem Environmental Action
New York City

When the sixth of Manhattan's eight municipal bus depots was built in Harlem, like five others before it, it was placed right next to a middle school. The clouds of diesel exhaust from buses and from the many trucks that rumble through the center of Harlem—restricted from the highways on both sides of the island—have long left many residents wondering whether the diesel exposure was at least partly to blame for Harlem's high rate of asthma deaths among children. West Harlem Environmental Action (WE ACT), a nonprofit group organized by Harlem community leaders to pursue environmental justice in northern Manhattan, turned to the high school students enrolled in its after-school Earth Crew Youth Leadership Program to find out.

WE ACT, working with Columbia University and local health agencies, started training the older students in 1997 in the basics of epidemiological research. The Earth Crew then conducted in-depth health interviews of a sample group of students from the middle school, tracking their rates of asthma and smoking, for example, and other demographic information. Urine samples and lung function tests were taken. The data indicated detectable levels of diesel exposure in most of the students. In a later study, Earth Crew members donned air particle monitors themselves to find out just how dirty the air they were regularly breathing was at different high-traffic locations. They found the highest number of harmful air particles in the two areas with the highest exposure to diesel fumes—including the new bus depot by the school and a principal truck route.

The students who carried out these research projects learned a great deal about science, public health, and the research process. But they also raised the environmental awareness of their own families, their neighborhoods, and the broader community. WE ACT also helped them take their results to local government officials and the media, making the high rate of childhood asthma in Harlem and environmental justice a local political issue. (www.weact.org; 212-961-1000.)

PRINCIPLE 7:
USE TOOLS AND TECHNOLOGIES WITH MINDFULNESS.

Students should learn to use tools of all kinds—manual as well as electronic—with respect for the power of the tool, with responsibility, with deliberate attention to possible unintended consequences, with flexibility and resourcefulness, and with gratitude and wonder.

One of the most thought-provoking issues to explore with students and adults is the question of just how neutral our technologies really are. Is a technology really "only a tool," able to be turned to good or harmful purposes depending on the skill and intention of the user? Or do the particular qualities of the technologies we create change us in ways we had not intended? The history of military technology, for example, argues against the simplistic view that technologies are merely instruments as opposed to critical factors actively at play in the shaping of human history.

Example: RSIHelp.com and the Cornell University Ergonomics Web

RSIHelp.com is the web site of Deborah Quilter, author of The Repetitive Strain Injury Recovery

Book. *Both her site and Cornell's site, called CU Ergo, provide basic prevention tips, exercises, resources, and advice for dealing with the risks and realities of repetitive stress injuries related to overuse of computer keyboards, video games, and other key-operated electronics, including pages that focus on protecting children from injuries. (www.rsihelp.com/children.shtml and http://ergo.human.cornell.edu/CUEHinfo.html)*

PRINCIPLE 8:
TO TEACH TECHNOLOGY LITERACY, BECOME TECHNOLOGICALLY LITERATE.

Parents and teachers can most effectively teach children to relate to technology in a healthy way by coming to terms with the impact of technology in their own lives and on the world around them. Developing technology awareness as adults will help us model a mature relationship to technologies new and old—the most compelling way to help students develop such maturity.

Example: Integrating Technology Across the Curriculum (K-12)
North Carolina Agricultural and Technical State University

This course for students seeking graduate degrees in education has an unusual focus on the perils, as well as the promises, of integrating advanced technologies into K-12 education. It emphasizes critical examination of the social impact of technologies throughout history. Videoclips of cultures that develop and use technology in both unifying and divisive ways are used in the course to provoke discussion.

Students study major technological milestones such as the airplane, the wheel, and the clock to examine how technical advances can both amplify and reduce human capacities, as we allow machines to take over tasks that humans were once proficient at doing. Readings for the course include critiques of K-12 educational technology, samples of state and national standards for technology integration, evaluation of local technology policies and plans, and resources posted by the National Academy of Engineering. Students also work with the instructor to choose and carry out action research projects, such as studying the developmental risks to children in local classrooms from intensive use of advanced technologies in the early grades. Students also work in groups to propose their own sample guidelines for technology literacy. (Contact: mjost@ncat.edu.)

PRINCIPLE 9:
HONOR THE PRECAUTIONARY PRINCIPLE: WHEN UNCERTAIN, ERR ON THE SIDE OF CAUTION.

- Ask tough questions about long-term consequences.
- Make time, space, and silence for reflection.
- Responsibility grows from humility.
- Be resourceful with the tools you already have.

The Precautionary Principle is a model for responsible technological decision-making promoted by the Science and Environmental Health Network and others. It states: "When an activity raises the threat of harm to human health or the environment, precautionary measures should be taken even if some cause and effect relationships are not fully established scientifically. In this context, the proponent of an activity, rather than the public, should bear the burden of proof."[1]

Ask tough questions.

De-emphasize easy answers and re-emphasize tough questions in education. To make wise decisions about which technologies to develop and how to apply them, democratic societies rely on the capacity of citizens to freely engage in public dialogue about the ramifications of those decisions. In this context, courage in probing deeply and extensively into potential consequences is essential. This

Responsibility is the ability to be responsive to the real world—to listen, to understand, to appreciate, to serve, to support, to participate.

kind of critical analysis is more likely to be encouraged by schools that reward thoughtful questions, not memorized answers.

The current focus on standardized testing tends to reward and rank students by the answers they have memorized. The technology challenges of the 21st century, however, require an active public that is more capable than has ever before been necessary in forming and confronting daunting, even terrifying, questions about the design and use of new technologies, both in personal reflection and public conversations. The quality and the range of the questions we dare to ask, as individuals and as communities, are likely to be directly related to how destructive or constructive new technologies will be. Encourage the asking of why and why not, and help students to avoid assuming that there is only one answer to many of the most important questions – or only one way to solve a problem.

Example: Kids Can Make a Difference.

A nonprofit organization based in Connecticut that provides teachers and students in middle and high schools with resources to take up one of the most neglected and disturbing questions of all—why do so many people go to bed hungry in the United States and around the world? The answer, it turns out, is not the oft-repeated assumption that there is not enough food produced to feed all of the world's peoples. Technically, the food supply is adequate, although much of it is diverted to fatten livestock and farm-raised fish for the world's wealthier consumers. A whole pattern of human choices in the realm of economics and politics has traditionally led to a tragic misdistribution of food resources.

Kids Can Make a Difference encourages students to consider the social and political aspects of the question and to discuss what changes in policies—especially at the democratic level of citizen involvement—are likely to actually get food to those who are now hungry. Its teachers' guide, for example, asks students to analyze the impact of technical innovations on hunger and poverty and to question the assumption that the benefits of technical advances in genetic engineering and other areas will accrue to those most in need. The organization also provides practical mentoring for teachers so they can help students apply what they have learned, along with the passion that the issue of hunger inspires in them, to take some small action of their own to alleviate the problem.

For example, Kelly Hayes, a middle-school teacher in Gorham, Maine, has used the group's guide to build her classroom curriculum around questions with no pat answers. She has challenged students to think about the moral context of issues such as hunger and poverty and why such injustices are so prevalent. The teachers' guide also includes suggestions for actions that middle-school and high-school students can take themselves to increase public awareness and public action on these issues. Ms. Hayes's classes have created a public performance at the Portland Museum of Art called "Faces of Hunger," combining music, drama, dance, writing, and art; public service announcements written and produced by students and aired on NBC; a World Hunger Fair to which they invited politicians; and a youth leadership camp. (www.kidscanmakeadifference.org; 860-245-3620.)

Reflect.

Reflection is essential to transform teaching into learning, but the speed and power of advanced

devices often distract and divert students from reflection. The value placed on speed and stimulation in our high-tech culture has reduced time for reflection. Reflection helps to develop a conscious relationship to the powerful technologies in our midst. Give children the tools they need for inner exploration of feelings, thoughts, and reactions, as well as the tools for exploring the world outside themselves, and the seamless living web that makes the two one.

Example: Peace Garden, Vancouver *British Columbia, Canada.*

Students at the Gladstone Secondary School transformed a small grassy courtyard at the school into a Peace Garden. They weeded invasive species from the area and replanted it with species that reflect the cultural and natural heritage of British Columbia and that provide a habitat for wild birds. A Peace Pole stands in the tree-shaded garden. The space now provides students a space to gather quietly and, as the teacher who helped them puts it, "nurture peace" within themselves, their school community, the global community, and nature. The students who planted the garden were part of a Youth Stewardship Initiative sponsored by the Evergreen Foundation in Canada. They are now mentoring and training younger students to help maintain it as a native plant habitat. (www.evergreen.ca/en/lg/ysi/html; Gladstone Secondary School: 604-713-8288 or 604-689-0766.)

Practice humility.

Those who will benefit from the use of a new technology have a responsibility to examine the full costs related to its use before deciding to proceed. Even after such deliberations, individuals, families, and communities should also consider temporary trials of new technologies, with a review of the actual effects scheduled at some agreed-upon date after their introduction. If there are anticipated costs associated with the use of a new technology—or an old technology—that no one is willing to commit to paying, its use should be delayed until someone steps forward who is willing to do so.

The nearly 60-year history of Congress being unable to agree about where or how to dispose of mounting nuclear wastes as well as current fears about the development of nuclear weapons in many politically unstable countries are both stark examples of the dangers of ignoring this principle.

Example: The Talking Circle.

The way of the circle, a Native American democratic tradition, is a timely tool for democracy today in schools, prisons, and community centers. Traditionally, the circle begins with all participants gathering to greet and give thanks to the Earth, to all creatures of the Earth, to the whole circle of the universe, and to the Creator. This invokes the original spirit of humility, which stems from the Latin humus, meaning the earth, or ground. The circle also invokes the circle of life, its unity, and the interrelatedness of all its dimensions. An elder begins first, holding the talking stick as he speaks, and then passing it around the circle for each one present to speak her mind while holding it and to listen with respect and attention while not. Its beauty for children is in the silent invitation to each person present to listen and to speak from the heart as well as the mind. (www.circleway.org; 603-878-2310; or Medicine Story, 167 Merriam Hill Road, Greenville, New Hampshire 03048.)

Be resourceful.

In the past, teachers were rewarded and respected in part for the ingenuity and creativity they brought to making academic magic with whatever limited resources their schools could afford. Of course, this is a powerful model for students of all ages about the possibilities of human resourcefulness within a context of respect for limits. Today, teachers are more likely to be penalized for not rethinking their curriculum—even for very young

children—in ways that demand advanced electronic equipment that is expensive, educationally unproven, and expected to become quickly obsolete.

In our passion for technical innovations, our culture has lost a sense of the much broader possibilities of human creativity. Wise technical innovations, undertaken in a spirit of living within limits, can certainly be a powerful source of addressing the ecological damage to which past innovations, such as automobiles and chlorofluorocarbons, have already contributed. But more essential to relieving many social and ecological crises is the recognition of how much can be done today—within the limits of our existing scientific knowledge and technical capacities—to resolve these crises, given a strong sense of public commitment and shared purpose. To achieve that kind of shared commitment, we need to pursue a social agenda, not a technical agenda.

Example: Turn the Tide with the Center for a New American Dream.

Turn the Tide is a program of nine simple actions that any family or school community can take to protect the environment and, by reporting their actions at the web site of the Center for a New American Dream, get an immediate sense of the considerable joint impact of doing so with thousands of others.

New Dream asked scientists and conservation experts to name some first steps Americans could take to reduce global warming, conserve water and energy, and save wildlife and forest habitat. From that list, New Dream chose nine actions with proven quantifiable results that most Americans could fit into the busy pace of their daily lives without significant sacrifices—like skipping a car trip once a week, replacing one beef meal a week, getting off of junk mail lists, and setting their thermostats three degrees lower in winter and higher in summer. New Dream uses a powerful web interface to let participants report back their efforts and to estimate immediately the impact of their individual actions to date, and the combined impact of everyone participating in the program to date. The project is an unusual example of the power of harnessing socially innovative thinking to technical innovation in a way that can be especially inspiring to older students. It is "interactive" in the true sense of that word. (www.newdream.org and www.turnthetide.org; 877-683-7326.)

PRINCIPLE 10:
RESPECT THE SACREDNESS OF LIFE IN ALL ITS DIVERSITY.

Childhood is the time to nurture a sense of the beauty and sacred nature of all life. Students who grow up with a strong sense of the value and meaning of human life and of other forms of life will be less likely to choose high-tech simulations that are a pale imitation of life. They will develop gratitude for the unique qualities of life—such as its diversity and unpredictability—in contrast to the realm of human engineering, with its insistence on standardization and control.

Death, too, is an essential part of the life cycle. Students can learn to respect and value the reality of death and mortality, as a vital part of the inherent generosity of one generation of life nourishing the next.

Such a perspective may help students more freely evaluate the marketing of invasive technological "enhancements" to the human mind and body and to other living species. They may also reflect on our culture's almost phobic shunning of the natural processes of decay and death.

Life is far more complex, uncontrollable, and ever-changing than any technology yet introduced. Wes Jackson of the Land Institute in Kansas suggests that the social and ecological impact of human inventions will be far more life-sustaining when engineers learn to more consciously mimic nature's laws of design in developing new technologies. As it is, advanced technologies today too

often substitute standardization, monoculture, hazardous wastes, and the pursuit of speed and centralized control for nature's diversity, glacial pace, and intricately balanced harmonies of interdependence, in which nothing—even death—is expendable.

Example: Roots & Shoots, the Jane Goodall Institute.

The Jane Goodall Institute's global environmental and humanitarian program for children and adolescents provides resources, support, and inspiration for youth to show their concern for all living things—the earth, animals, and the human community—through service projects in their communities. Roots & Shoots projects emphasize knowledge, compassion, and action as essential for serving life. For example, the institute helps youth set up local "Adopt an Abandoned Animal" programs, working with animal shelters to learn about and publicize the abandoned pet problem. It also helps fund and provide information for local youth-led peace initiatives aimed at increasing tolerance, compassion, and cultural understanding between diverse groups of people in communities. (www.janegoodall.org; www.rootsandshoots.org/; East Coast office: 301-565-0086; Berkeley office: 510-420-0746.)

Example: All Species Festivals

A Santa Fe tradition has grown up over the last 20 years and spread to other cities in the United States and elsewhere. Schoolchildren research a chosen species over a period of time, write about it, and create masks and costumes to don in "all species parades" and "creature congresses." In the latter, each creature represented gets a chance to stand before the mock legislative body and describe its own case for humane and ecologically sensitive treatment of its own species. Emotional and aesthetic reasons are considered as valid as scientific or economic ones. Students also sometimes take the concerns that come up at such congresses to their own elected officials or organize letter-writing campaigns to try to change the environmental policies of governments or companies. (www.allspecies.org; Heartland All Species Project, 5644 Charlotte, Kansas City, MO 64110, 816-361-1230.)

A significant minority of young adolescents are literally screening out the social and emotional challenges of adolescence.

Example: Crossings: Caring for Our Own at Death.

This small educational nonprofit in Maryland provides information and support to families who want to take some or all of the responsibility for after-death care when a loved one dies. Crossings was started in 1995 by Beth Sanders after the death of her seven-year-old daughter, Alison. It encourages families to keep alive or rekindle cultural traditions of washing and dressing the body at home, and inviting families and friends into the home for around-the-clock vigils in the days just after death. People who attend a death commemorated in this kind of home and community setting report feeling a reverence that is similar to the reverence they feel when present for another powerful life passage—birth. The warmth and naturalness of this kind of home-centered care after death is especially nourishing when children lose someone dear to them, as it embodies death as a sacred phase of the cycle of life. (www.crossings.net; 301-593-5451.)

References

1 Quoted by SEHN from the 1998 *Wingspread Statement on the Precautionary Principle*, www.sehn.org/precaution.html (last accessed September 2004).

Chapter 6
Developmental Guidelines for Technology Literacy

"I am struck by the fact that the more slowly trees grow at first, the sounder they are at the core, and I think the same is true of human beings. We do not wish to see children precocious, making great strides in their early years like sprouts, producing soft perishable timber, but better if they expand slowly at first, as if contending with difficulties, and so are solidified and perfected. Such trees continue to expand with nearly equal rapidity to extreme old age."

—Henry David Thoreau

Each child's growth is unique, but childhood itself is characterized by general patterns of physical, emotional, social, and cognitive growth that are remarkably complex, intricately coordinated across many years, and deeply rooted in biology.[1] Overemphasizing one aspect of development, such as the cognitive, can mean endangering another, such as social-emotional development. In general, it is best to provide stimulation in all areas to foster balanced growth while honoring the child's own unique timetable.

Honoring children's innate developmental processes seems to be especially difficult in the United States, where we like things to be faster and bigger than normal. Many Americans want to give their children a competitive edge in the world. The Swiss psychologist Jean Piaget, who described children's developmental stages, did not enjoy lecturing in the U.S. After each talk, he said, he was always asked what he came to call "the American question": "But how can we get our children to develop faster?"[2] Many parents want to give their children a competitive edge in the world, but do so at a price.

There are many ways to get children to do things faster. The problem is that so far no one has found a way to speed up children's development and still have long-term growth that is healthy, balanced, and sustainable. Instead, when you speed up children too much at one stage, they are likely to burn out further down the line.

A current example of this problem is parents pushing children into competitive sports at age five or younger. *Time* magazine reports that increasing numbers of children are burning out and quitting sports as a result.[3] Pushing children in this way not only burns them out but can have significant impact on their physical form and skeletal structures, the formation of the bones, the elasticity of their bodies, and their ligaments and tendons, not to mention the distortion of their competition-oriented social skills and self-image.

A large body of research across many fields—broadly referred to as developmental science—illustrates the essential biological and social reality of children's development. Recent brain research shows that, even in adolescence, the brain is still "a work in progress."[4] Imaging studies indicate that the neural connections that enable effective communication between the brain regions related to impulse control, emotions, and critical judgment may not fully mature until the early twenties.

"We like to think that maturation is based on a lot of experience, but even in adolescence we also have to recognize that learning may not count so much until the underlying brain structures are in place," notes Peter Jensen, M.D., of Columbia University, former head of child and adolescent research at the U.S. National Institute of Mental Health.[5]

Nevertheless, sales of "Baby Einstein," "JumpStart Baby," and similar computer "lapware" continue to climb. In some school districts, all-day preschools are too busy with reading, math, and science lessons to make time for naps or daily opportunities for music and art that are far better tuned to the needs of the young child. Reading and math drills tied to standardized tests are replacing child-initiated play in kindergarten classrooms and recess for older children, despite extensive evidence of the cognitive and social advantages of childhood play.[6] And schools are under great commercial and political pressure to integrate new electronic and communication technology into classes across the curriculum, from preschool on up.

Denying young children opportunities for physical activity and creative play can have a significant impact on their development. "It is possible," writes Dr. Jeffrey Kane of Long Island University, "that if children do not have time to use their bodies to discover the world that they will greatly diminish, forever, their cognitive foundations for flexible, imaginative insight or understanding."[7]

Patterns of Growth

The gradual unfolding of the child's capacities is a never-ending wonder. One is humbled by the sheer magnitude of the changes that take place and the complex patterns that emerge.

Overall, the processes of childhood growth, including the physical maturation of the brain and nervous system, follow a certain pattern related to the evolutionary history of humanity. The brain's lower centers, controlling heart rate, breathing, and movement, evolved first, followed by the basic brain structures governing emotion, and finally by the neural regions that enable the most abstract manipulations of symbolic thought.[8] Eventually a rich network of connections between the regions of the brain involved in emotion and higher-order thinking integrates feelings and thought in even the most complex intellectual tasks.

Today many kindergartens expect five-year-olds to focus intensively for several hours a day on formal literacy and numeracy studies. This same practice is increasingly found in preschools for three- and four-year-olds. These practices raise important

questions about how much and when young children should be expected to focus on academic work, and whether they are helpful or harmful to children's long-term development. At the other end of childhood, high-school students are now pushed to take college-level courses. And adolescents who get in serious trouble with the law may be tried and sentenced as adults.

This pressure to rush children through childhood—and the expectation that they can and should achieve maturity at earlier ages—seems at odds with the recent findings of brain research, which indicate that the healthy human brain is still undergoing significant development well past puberty. In fact, the brain may not be fully mature until the early 20s, according to Jay Giedd of the National Institute of Mental Health.[9]

After puberty, the prefrontal cortex undergoes significant development. This is the locus of the brain's most complex analytical thinking, involving, for example, planning and critical judgment. Even in late adolescence, a rich network of neural connections is still maturing between this area and brain regions most directly involved in emotion and movement.

Researchers continue to look at how the long process of neural development and integration affects human behavior.[10] But childhood also clearly involves patterns of behavioral development. From the earliest stages of sucking on fingers and toes, to walking, climbing, and running, the young child gradually grows into his body. The stumbling toddler grows into a young adult who races in triathlons or climbs mountains. Chubby little hands become dexterous. It is a joy to watch an adolescent learn to do fine woodworking and to recall his first clumsy efforts with hammers and nails in preschool.

Likewise, childhood is marked by a growing competence in emotional, social, and intellectual skills. When a two-year-old is frustrated, we are not surprised if she throws a tantrums or bites. By seven, she has learned—within limits—to share and wait her turn, and her nervous system has matured enough to support such learning. By 21, she may be a budding diplomat, skilled in making her own needs known with tact and humor and responsive to the needs of others.

Reading and math drills tied to standardized tests are replacing child-initiated play in kindergarten classrooms and recess for older children, despite extensive evidence of the cognitive and social advantages of childhood play.

In first grade, a child may struggle to spell out his own name. By eighth grade, he is already dipping into the world's great literature and writing short stories of his own for fun. By 21, he may not only comprehend complex philosophical treatises but insightfully analyze them in writing.

The art of raising and educating children means offering love and support at every stage of their development. It requires recognizing and honoring the innate patterns of development in children and having a comprehensive understanding of their vital developmental needs.

The Healthy Essentials of Childhood

The essentials of a healthy childhood start with matters literally of life and death: good nutrition, shelter, clothing, medical care, and a healthy environment. But there are other essentials whose contribution to the child's development is subtler yet still vital:

Close, loving relationships with responsive adults, at home and at school. Human warmth and care is at the heart of nurturing children from infancy on up.

> *"I do not know what I may appear to the world, but to myself I seem to have been only like a boy playing on the seashore, and diverting myself now and then finding a smoother pebble or a prettier shell than ordinary, while the great ocean of truth lay all undiscovered before me."*
>
> —*Isaac Newton*

It is easy to see this in the case of infants and young children. But a growing body of research indicates that adolescents are more likely to thrive in schools small enough for them to be known by name.[11]

Direct knowledge of the living world of nature, developed through outdoor play, exploration, gardening, and other encounters. For the very young child, this means plenty of time to explore the minute miracles of the backyard or park. Elementary students can enjoy class hikes and camping with families or scout troops. Adolescents, with a bit of help from adults, can thrive on extended wilderness experiences.

Time every day for child-initiated play. For young children, make-believe play is particularly important, starting around age two or three, when children begin to try on all the aspects of life they experience. Through play they get to know themselves and the world around them. Before this their play is more physical, but also very important, as they explore their fingers and toes and the physical objects around them. In grade school, imaginative play advances to acting out original dramas and building forts and club houses. At this age, play also matures into rule-based games. Eventually this becomes the basis for formal sports, where others set the rules. But in the early years children naturally create their own rules. In middle and high school, the imaginative spirit of play, if kept alive, can grow into more mature forms of intellectual and artistic creativity.

Music, drama, puppetry, dance, painting, and the other arts. These should be offered as separate classes throughout childhood and also blended into academic subjects as a kind of yeast to the child's growing imagination. A well-developed imagination enhances all forms of thinking, from philosophy and history to science and mathematics, as well as in the arts.[13]

Hands-on lessons, handcrafts, and other physically engaging activities. Such activities literally embody the most effective first lessons for young children in the sciences, mathematics, and technology. What is learned through the hands stimulates a large part of the brain[14] and enters deeply into the life of the child.

Rich face-to-face language experiences, including conversation, poetry, storytelling, and books. Reading books aloud with favorite adults is especially crucial for young children. And the living relationship between the teller and the hearer of stories makes oral storytelling a compelling educational tool for both preschool and the primary grades. Adolescents also love hearing stories, whether in the classroom or around a campfire. Spoken stories engage all of the child's senses, emotions, and imagination. That makes them, in the words of ecologist David Abram, "the necessary intermediate ground between our sensuous surroundings and the abstract world of information and cool reason."[15]

Time and space for children to create meaning and experience a sense of the sacred. Children have an innate sense of wonder and reverence for the beauty, goodness, and sacredness of life. They experience gratitude for the sunshine, clean water, fresh air, and fertile soil that combine to help grow the food that keeps us alive. They hunger for beauty in color and form, both natural and fashioned by human hands,

and this too nourishes a sense of the sacred.

A strong body of research—including recent studies of the developing brain—as well as the practical experience of generations of teachers and parents support the emphasis we place on the healthy essentials. We include here just a few examples.

Many of the nation's leading authorities on children's health, development, and education—including psychologists Jane Healy and David Elkind, pediatrician T. Berry Brazelton, and child psychiatrists Stanley Greenspan and Alvin Poussaint—are concerned about early childhood education that stresses early literacy and eliminates or seriously reduces child-initiated play. They argue that young children learn best—and are most likely to thrive in every other way as well—when they are allowed to explore the world in a multi-faceted, playful way.[16]

Many authorities note the importance of relationships for healthy lifelong development. Urie Bronfenbrenner, professor emeritus of human development and family studies at Cornell University, suggests that the fundamental need of children to have strong emotional bonds with people committed to their well-being is a principle of human development that applies "anytime up to the age of, say, 99."[17]

The brain is not an isolated organ in the body. It is linked to everything else: to language, to movement, to physical, social, and emotional experiences. When the hands, the eyes, the ears, and the heart are being stimulated through life activity, so is the brain. "The structure and function of the developing brain are determined by how experiences, especially within interpersonal relationships, shape the genetically programmed maturation of the nervous system," explains Daniel Siegel of UCLA in his 1999 synthesis of neurobiology, cognitive science, and research from other disciplines on human development. "In other words, human connections shape the neural connections from which the mind emerges."[18]

Neural scientists now believe that the development of one region of the brain that plays a vital coordinating role, the orbitofrontal cortex, depends on stimulation from emotional connections to attachment figures, such as parents or other caregivers, "in the form of eye contact, face-to-face communication, and affective attunement," Siegel adds. This brain region, which is just behind and above the eyes, has specific cells that are "particularly responsive to facial expression and eye gaze direction." But the orbitofrontal cortex "is also crucial in coordinating bodily states and the widely distributed and linked representations that are fundamental to reasoning processes, motivation, and the creation of emotional meaning."[19]

Studies of the developing brain have also indicated the importance of physical activity and hands-on experiences in stimulating brain growth.[20] Indeed, a disproportionately large part of the human brain is linked to the hands.

"I would argue that any theory of human intelligence which ignores the interdependence of hand and brain function, the historic origins of the relationship, or the impact of that history on developmental dynamics in modern humans, is grossly misleading and sterile," says neurologist Frank Wilson.[21]

Child-initiated imaginative play is connected to developmental gains across all areas, including cognitive growth.[22] Some leading scientists have also linked the delight they experienced as children in the creative flow of their own play to the pleasurable absorption they experience in their most creative intellectual moments. Sir Isaac Newton, for example, compared the creative zest that fueled his own scientific career to play: "I do not know what I may appear to the world," Newton wrote, "but to myself I seem to have been only like a boy playing on the seashore, and diverting myself now and then finding a smoother pebble or a prettier shell than ordinary, while the great ocean of truth lay all undiscovered before me."[23]

There also seems to be a connection between playfulness and a sense of wonder and appreciation for the goodness of life. Edith Cobb extensively studied the childhood roots of adult genius across many cultures and time periods. She found that many described vivid memories of similar profound experiences of nature in childhood—often in the midst of play. Common to these moments was both a sudden sense of separate identity and—at the same time—a joyful, intense awareness of being immersed in and part of the whole cosmos of forms and colors and motion around them. These memories, described by so many great thinkers, artists, and scientists, suggest "some universal link between mind and nature," not yet fully understood but intuitively latent in human consciousness. The very memory of those moments, she added, seems to trigger within creative adults a renewal of the power and impulse to create.[24]

The sense of wonder is closely linked to the spirit of scientific inquiry. Scientists emphasize the value of questions, rather than answers, in advancing human knowledge. To nurture a zest for science, then, parents and schools can encourage children to generate their own thoughtful questions and to let good questions arise from their own imaginations. That means resisting the temptation to provide literal textbook answers when a toddler issues an open-ended invitation to share a moment of wonder, such as "Why is the sky blue?" It also means finding a balance between the current emphasis on a uniform set of questions and answers in standardized tests with the healthy pursuit of one's own questions and answers.

The Nobel physicist Isidor Isaac Rabi gave this example from his own childhood:

> My mother made me a scientist without ever intending it. Every other Jewish mother in Brooklyn would ask her child after school: "So? Did you learn anything today?" But not my mother. She always asked me a different question. "Izzy," she would say, "did you ask a good question today?"

The Healthy Essentials as a Foundation for Technology Education

The healthy essentials can inform classwork from preschool through high school. They are central to the education of young children, but remain just as important as children grow older. In high school, where the emphasis is more on the development of thinking, including abstract thinking, examples drawn from the arts, nature, and human relationships will often stimulate the deepest thinking and engagement.

An education that emphasizes emotional, physical, and sensory engagement in real life will inspire the sense of urgent purpose that can move students to devote their lives to meeting human needs and to protecting the whole fabric of life on Earth.

When grounded in living relationships, older students can gradually comprehend just how deeply rooted our technologies are in the laws and materials of the natural world and how our inventions, at best, poorly imitate life. No technology can match the full spectrum of qualities, the subtle harmonies and balance, and the sacred meaning that is inherent in every form of life, and in the infinitely complex and seamless patterns that compose the whole of life. As David Abram puts it, "the palpable, sensuous world that materially surrounds us" draws us into relationship with "a diversity of beings as inscrutable and unfathomable as ourselves." He adds:

> Let us indeed celebrate the powers of technology, and introduce our children to the digital delights of our era. But not before we have acquainted them with the gifts of the living land, and enabled its palpable mysteries to ignite their imaginations and their thoughts. Not before we have stepped outside with our children, late at night, to gaze up at the glinting lights scattered haphazard through the fathomless dark, and sharing a story about how those stars came to be there.[26]

To help children come to grips with the power and responsibility of technology, then, at least

through the elementary years, we should impose very little technological intervention between child and nature or child and fellow human being. Later, adults can serve as mentors, guiding middle- and high-school students to learn how to assess the social effects of technologies and to operate computers and other advanced technologies safely and responsibly.

When one questions the use of computers in elementary schools or preschools, the most common rebuttal one hears is that a computer is only a tool. Yet there are all kinds of tools in the world, some potentially far more dangerous than others. And there is a world of difference between giving a young child a small handsaw or a large chain saw. Both, of course, are tools. Likewise, it's one thing for a three-year-old to pedal around in a toy car and quite another to put him behind the wheel of an SUV.

Guidelines for Early Childhood

Young children are developmentally primed to explore life through their limbs and their senses. They want to touch, taste, smell, see, and hear the life around them. They want to climb and run, leap and balance, speak and shout, sing and dance, laugh and cry. They enjoy interacting with the world and creating new worlds in their play with the objects at hand—sticks and stones, sand and toys, crayons, shovels, and hammers. The world is full of objects that become play materials and tools for learning.

When actual tools are given to children the tools should engage their bodies, hands, and hearts in ways that foster close relationships with other people, that help them explore nature and stimulate their own creativity. Tools that inhibit that direct engagement, or impoverish it by shrouding it in abstractions, should be avoided.

When a child of four or five picks up a crayon, he is likely to draw the same motifs found among children his age all over the world, albeit with unique qualities of his own. Drawing is an important part of discovering self and communicating with others.

After each U.S. talk, psychologist Jean Piaget was always asked what he came to call "the American question": "But how can we get our children to develop faster?"

Give that same child a computer program for drawing and something quite different happens. The creative work comes much less from the depths of the child and much more from the adult programmer's imagination. Once the child begins using the computer for drawing, he often stops valuing his own drawings and finds them inadequate. He shies away from an activity that is important for self-expression, as well as for getting the hand ready for writing and other work.

Children enjoy using the tools they see adults use, but it is best to give them simple tools that interpose themselves less prominently between the child and the world. Simple tools reward the efforts of the child to understand how the tools work. At this age, children benefit from tools that promote concrete, direct, and physically engaging experiences with the world around them. In contrast, the computer is so powerful and so complete in itself that there is very little of substance the child can do to understand or change it.

Another important aspect of early childhood is the way children learn from adults and other children. They observe carefully and imitate the gestures, language, and moods of others. There is no evidence that children can absorb the same lessons from a screen. Some narrow skills may be taught with computers, but the bigger lessons of life such as caring for others, cooperating with them, and

engaging in complex communications with them need to be learned within the bounds of human relationships. Computers cannot teach these lessons, yet the more time young children spend in front of them the less time they have to learn from adults and other children.

The Primary Grades

As the child begins to move into the world of abstract symbols through learning to read and write, the same general rule about tools applies. Keep them simple and don't let them intrude between the child and the lesson. As Theodore Roszak has observed, "Placing a complex machine between the student and reading and writing puts more distance between intention and result."[27] Even reading itself imposes a certain cognitive distance between the child and the subject being read about. That makes it critical that early reading experiences include caring adults whose presence helps establish imaginative connections between the lines on the paper and the living world experienced by the child. It is also why a strong experience of oral language in the form of play, conversation, and storytelling is a necessary precursor to written language.[28]

The primary grades encompass a long period in which the capacities and needs of a child change dramatically. A wide range of psychological evidence indicates that, prior to age 7 or 8, children approach the world more imaginatively, playfully, artistically, and sensually. After this age they are more logical, rational, and matter-of-fact. This change is generally known as the "five-to-seven-year shift."

A developmental approach to technology literacy should reflect this dramatic shift. Younger children will be most engaged by simple tools and techniques; older children will be drawn to more robust and complex ones, especially more physically challenging handcrafts and tools. Musical instruments are an ideal example, as every child deserves a chance to become musically literate. That process can begin by making simple instruments with high-quality sound freely available to young children. By the later elementary years, every child should have repeated chances for formal lessons on the violin, piano, or other string and wind instruments. Basic musical knowledge and skill on an instrument will enhance the child's life and open the door to a wide world of sharing music socially.

Whatever the tool or the instrument, what changes little over this time is the necessity to match the level of technical complexity with the level of the child's ability to comprehend that complexity. In this way, too, the child's budding imagination can be engaged at every step with the tools rather than feeling overpowered by them.

Of course, given the prevalence of advanced technologies in our everyday lives, it would be foolish to believe that children can be isolated from involvement with technologies whose workings are beyond their comprehension. But we do not have to expect or encourage them to operate such machinery themselves, either at home or school. In fact, both home and school are, by design, protected environments, whose historical responsibility it has been to determine what experiences are worthy of, and healthy for, children.

Technology literacy for schoolchildren involves re-conceiving our homes and elementary schools as places that consciously moderate children's encounters with machinery whose operations they cannot understand.

Marshall McLuhan, the late scholar of media and their social impact, sensed this changing role for education and called it "civil defense against media fallout." Though often portrayed as an advocate of high technology, McLuhan understood that children need developmental time, space, and experience away from the products of advanced technologies in order to grow into sophisticated "readers" of technology.

It may seem paradoxical that early exposure to technology could actually hinder the development of real technological literacy. But a great many of the scientists and engineers who developed computers did not themselves use computers as children and instead spent much of their youth tinkering with short-wave radios and cars. That is, they used their hands to build things and to solve problems. Is it possible that a younger generation of programmers and engineers, raised on computers rather than jalopies, will be less capable of finding creative solutions to problems than their older counterparts?

The gradual progression of child development toward a more sophisticated understanding of the world should be accompanied by a gradual progression in using and investigating more sophisticated tools. That point is fundamental for a developmentally healthy technology literacy program. But another point is equally important. The change in both realms is not just a matter of "more." It is a matter of differences. Each phase of childhood calls for different experiences with technologies.

The Middle-School Years

The middle-school years are marked by a noticeable shift in the child's character: toward establishing one's own identity and independence, especially in the social realm. Puberty and emerging sexuality result in enormous changes in appearance and social interests, and draw forth an emotional ambiguity that alters the relationship between youth and adult. Parents, who earlier provided security and protection, now are called upon to provide support and encouragement as the more competent youth begins moving out into the world with a greater sense of autonomy. At the same time, children at this age still learn best when physically active—building things, writing plays and newsletters, gardening, role playing, and actively experimenting.

A healthy relationship with technology will come from recognizing that face-to-face relationships are crucial to building strong personal friendships and a sense of community that now extends well beyond family. It will encourage, or at least not get in the way of, participation in that community in purposeful and beneficial ways. It will acknowledge the importance of expressive activities such as art, music, theater, and sports, which provide young people opportunities to communicate the strong aesthetic and emotional energy that typically accompanies this stage of life.

The great threat for middle schoolers today is isolation—from family, community, the living world—even from a brave exploration of their own inner world. Computers and the internet can begin to play a role at this age in helping young people make healthy connections to the larger world. But technology use that diminishes opportunities for mutual activity—or that distracts young people from self-discovery—should be discouraged, especially if there are signs that it is becoming obsessive or addictive.

A conscious effort must be made by communities to embrace youth and begin a healthy process of drawing them toward the adult world. This is the time of greatest vulnerability, when social and psychological identities are undergoing their most powerful and often painful transitions. But many young adolescents are cast adrift in an ocean of technologies that offer retreat from, rather than full engagement with, adults and peers. Video games are the default replacement for social life for many troubled youth, especially boys. Televisions and computers in bedrooms, internet chat rooms, and telephones are often viewed as links to the outside world. But they often serve as tools for youth of this age to isolate themselves from the more difficult but crucial face-to-face interactions with parents and peers that pave the healthy transformation from dependency to maturity.

The living relationship between the teller and the hearer of stories makes oral storytelling a compelling educational tool for both preschool and the primary grades. Adolescents also love hearing stories, whether in the classroom or around a campfire.

Similarly, as youth are pulled ever more powerfully into a high-tech world of human design, it is essential that they maintain a connection with the natural world. They need an appreciation for the primacy of nature. Many middle-school students now experience nature mainly through screen images. "Knowledge" may be conveyed readily in this medium, but the experience of that knowledge remains distant.

In Stephen Talbott's book *The Future Does Not Compute*, a father relates this story:

> Yesterday my 11-year-old son and I were hiking in a remote wood. He was leading. He spotted [a] four-foot rattlesnake in the trail about six feet in front of us. We watched it for quite some time before going around it. When we were on the way home, he commented that this was the best day of his life.

The father then went on "to wonder how many armchair nature-watchers have seen dangerous snakes on the tube and said, 'this is the best day of my life.' "[30]

Similarly, as youth are pulled ever more powerfully into a high-tech world of human design, it is essential that they maintain a connection with the natural world. They need an appreciation for the primacy of nature—that the world of human design is dependent on nature and that our health as a civilization depends on the health of the natural world. Technology literacy at this age includes exploratory conversations that examine the character and differences of the natural and technical worlds.

The middle grades are also an appropriate time to begin an explicit exploration of the ethical responsibilities of using computer-based tools. As students learn to do online research, they can be introduced to the rules of proper attribution and crediting of sources, as well as to the practice of asking questions about the credibility of the information they find. While elementary students may talk about issues of right and wrong in relation to tools they use, it's difficult for them to go beyond their own particular, concrete experiences. The general, more abstract discussion of ethics should wait for middle and high school.

As these middle-school students become absorbed with relationships and the dynamics of human interaction, the effects of technologies on human relationships is a valuable and relevant subject for exploration. They also are developing critical skills, so they are ready to examine how commercial interests target them as consumers. This is a good time to raise issues of the use of technology for advertising, propaganda, privacy, and personal information gathering into their studies.

As students begin exploring issues of drug and alcohol abuse, adults can include investigations into the addictive power that TV, video games, and computers exert over some youth[31] and the impact that has on both youth culture and culture at large.

In middle school, when students show an increased interest in media and technology, a variety of electronic tools may become useful, both as occasional objects of study and occasional objects with which to study.

For example, studying the fundamentals of how television and television broadcasting work may correspond with the entry of the TV into the classroom as an occasional learning tool. But just as this stage of life benefits greatly from strong mentorship, so does the entry into mediated communica-

tion. To abandon adolescents to the internet or TV without the guidance and companionship of caring adults is an abandonment of commitment to technology literacy.

As Stephen Talbott has pointed out, one consequence of the ever more elaborate tools that have been invented to aid communication is that "the word has increasingly detached itself from the human being who utters it."[32] One of the goals of any technology literacy program should be to help young people recognize that condition and remain aware of the human at the other end of the electronic signal.

The High-School Years

The young person's move from middle school to high school is usually a dramatic one, in terms of new academic and social demands. But developmental changes are actually much more gradual. Young people continue to need lots of adult contact and social interaction with peers. They continue to need to establish their identities and personal competence.

They are also rightly striving for increased freedom. So adults must exercise a sensitive balance between allowing them more personal and social responsibilities, monitoring how well they are handling responsibility, and helping them learn from their mistakes. This balance should be reflected in students' growing responsibilities related to powerful technologies as well.

Teen-agers begin to think seriously about who they are in relationship to their future life beyond school. What they will need to live well outside of school begins to matter. At the same time, a concern for the kind of world they are going to have to live in can give rise to an idealism that seeks to be nurtured into a sense of efficacy.

It makes sense, then, for high-school students to experiment with high-tech tools, both in a lab setting where they can discover the principles behind the operation of these machines, and in actual use, where the tools' effectiveness and the ethical dimensions of their use can be examined first-hand. High school is where students can undertake the process of demystifying high-tech tools. They can discover how the tools actually work and recognize their limitations as well as their advantages. Here they can also learn important technical skills that will serve them as adults.

By requiring students to qualify for internet use based on their ability to show mature ethical and moral judgment, schools could educate those students on everything from "netiquette" to internet-facilitated plagiarism. Adult mentoring and modeling could be brought into play, with community standards, rather than quasi-laws, established as the operating force in technology use.

School communities should develop specific guidelines to help adolescents make a healthy transition to full, responsible use of advanced communication technologies at home and school. This would include strategies for helping them deal with hate sites and other inappropriate material. The guidelines would be an integral part of a technology literacy program for high school students, who themselves could take an active role in helping to develop them.

It is critical to link the developing moral imagination of high-school students with the availability of powerful tools that connect those students with a world they cannot experience directly. It is that moral imagination, just coming into bloom, that assists in taking responsibility for actions whose effects they cannot see. Whether it is in regard to telecommunications via the internet or political involvement in technological issues that affect their own community, technology literacy at this level should concern itself with the hidden as well as obvious social effects of technology.

Such an approach can better inform current practice regarding so-called acceptable use agreements, or AUAs. These are employed by school

districts across the U.S., in part because of an overeagerness to get young children on the internet before they can comprehend the responsibilities of using such powerful tools. The result has been an erosion of trust on the part of schools toward children, who are automatically suspected of desiring inappropriate material, and on the part of parents toward schools. Schools have indicated they no longer want to take responsibility for the material encountered by children within their own walls. Some schools now seem more concerned with avoiding liability than with fostering or modeling responsible behavior. Clearly, this is a question of educational responsibility, not liability.

Teaching Technology Literacy Through Community-Based Research and Action

Grounding the science and technology curriculum in middle school and high school in community-based research and community-based action is another key innovation to help students develop a new literacy of technology that is truly future-oriented. By "community-based," we mean providing students with practical opportunities to hone their research skills by focusing on some local issue or condition. That includes low-tech skills, such as asking thoughtful questions in their local communities and listening closely and critically for answers, as well as high-tech skills, such as internet searches, or, for high-school students, the use of advanced video equipment or electronic spreadsheets.

The definition of "local" can gradually be expanded, as children advance, from their own school and neighborhoods, to larger community, national, and even global issues. We emphasize community-based action because helping students apply the results of their investigations in a way that serves the needs of their own communities is a powerful, hands-on way to teach them that the practice of science and technology is always rooted in social and ethical choices.

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7 E-mail communication from Jeffrey Kane to Alliance for Childhood, Aug. 24, 2004.

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Chapter 7

Technology Education for Democracy: Guidelines for Citizen Action

Parents and educators can most effectively teach children to relate to technology in a healthy way by coming to terms with the effects of technology in their own lives and on the world around them. Developing technology awareness as adults will help us model a mature relationship to technologies new and old.

The habits of mindfulness and compassion we have described in preceding chapters are not enough to guide the design and use of technologies in the 21st century. We need a new sense of technologies not just as tools of convenience, entertainment, profits, and power but as social ethics in action, with opportunities for everyone's voice to be heard and heeded at every level—from neighborhoods to nations.

The initial decisions about what scientific questions to fund and which new products to develop and sell based on the results of that research are often made by a relatively narrow circle of experts drawn from government, business, and academia. And those experts usually have an ideological or financial stake in those decisions.

That experts-only model of technology policymaking is dangerously outdated. We call for a different model: broad public participation in choosing policies for research and technology that nurture the health of families, communities, and the local ecologies they depend on.

We need to educate children to be much more actively engaged in these issues. Commercial pres-

We call for broad public participation in choosing technologies that nurture the health of families, communities, and the local ecologies they depend on.

sures on individuals and competitive pressures on businesses to adopt an endless stream of new high-tech products have fed a broader cultural assumption of technological determinism—that technologies forge ahead under their own steam, independent of human influence.

As we noted in Chapter 1, the League of the Iroquois began every council meeting with an invocation to the "Seven Generations": "For each decision made or action taken, consider the effects on those who will live in the seventh generation from now." The new literacy of technology we propose is inspired by that spirit of mindfulness. Today's far more crowded and connected planet requires an even more expansive vision—one that explicitly applies the Iroquois invocation globally as well as locally. Our children could then bequeath to their children a new generation of tools—tools focused less on consuming and controlling and more on sustaining and serving.

Parents and educators can most effectively teach children to relate to technology in a healthy way by coming to terms with the effects of technology in their own lives and on the world around them. Developing technology awareness as adults will help us model a mature relationship to technologies new and old.

Start by Asking Hard Questions

The most crucial first step is to begin asking questions about the actual effects of technology in our lives. Here are some key questions to ponder:

What were the predicted effects of the technology, both positive and negative? And what were the actual effects—especially the unintended negative consequences—on the lives of your children, your family, our society, our world? Has anyone agreed to take responsibility for paying the costs of remedying unintended harm? Who will actually pay the tab for such remedies? Will the poor and most disenfranchised citizens pay a disproportionate share? For emerging technologies that are not yet fully developed or widely available, consider the full range of positive and negative consequences, but also consider the most probable of these.

What forces or interests are promoting the development and the use of the technology? Efficiency? The needs of the poor, the elderly, the sick or disabled? Profits? Fear? (Many parents fear, for instance, that children will later fail in the job market if they do not start learning about computers as early as possible. Although ungrounded, this fear has driven parents and schools to devote a great deal of time and money to bring even the youngest children into the world of computer technology.)

Have principles of ecological design been considered in the development and likely uses of a technology? Does the widespread adoption of the technology seem likely to increase or decrease biodiversity? What effect will its widespread adoption have on individual freedom, privacy, and security?

Would our grandchildren's future be brighter or dimmer if everyone who would like to use the technology actually did? Will the expected benefits of the technology be enjoyed by a wide range of people, or will they primarily accrue to those with the most money?

To what extent are you using the technology, and to what extent is the technology using you?

What are your personal and political options, locally as well as nationally, to address concerns you may have about the social, ecological, or political effects of the technology?

Methods to Develop Technology Literacy for Parents, Policymakers, and Citizens

Keep a one-week journal of your own personal technology use. Predict the amount of time you will spend with the television, computer, phone, etc., and the amount of time you will devote to family or outdoor activity that does not involve electronics. How close are your predictions to reality? Choose a pattern of use at the beginning of the second week, and then track how closely you are able to adhere to your own plan. Also, over time, if you decide to cut back on electronics in your leisure time, decide also what activities and relationships you would like to spend more time on instead. Then track your own record of adhering to your decisions.

Examine your own personal uses of simple, intermediate, and advanced technologies in light of the guidelines above.

Make a point of observing the proper ergonomics for working with technologies like computers and video games that involve highly repetitive motions, and also observe the recommended time limits and breaks to avoid repetitive stress injuries.

Advocate for institutions of higher education, including community colleges, to develop courses that explore the social and political effects of technology. Such courses should be available both for adults pursuing continuing education and for traditional college students. (See the appendix for a list of books, organizations, and other resources.) Such courses should be a prerequisite for obtaining a degree in computer science, engineering, and any field of science or social science—as well as a prerequisite for a degree in education.

Advocate for schools, community centers, and other public places that offer computer training or computer access to also develop and offer such courses at a reasonable fee, so that ordinary citizens have equal access to the powerful ideas, as well as the powerful equipment, that are at stake in a high-tech democracy.

Advocate for widespread opportunities for parents and others to participate in policy decisions about the use of new technologies locally and nationally. For example, encourage institutions of higher education to work with local communities to explore issues in which technology plays a role.

Declare one day or one night a week an electronic entertainment-free zone. This simple step could do much to revive the culture of childhood, family life, neighborhoods, and urban and rural community life. Try to coordinate that day with others in your neighborhood or school. Turn off televisions, computers, video games, cell phones, radios, etc., and minimize phone calls to create a space for everyone to focus their undivided attention on face-to-face relationships with each other and with the living world around them. This can also be a time for parents and children to slow down and enjoy spending time together in ways that teach children a range of practical low-tech skills, such as baking, gardening, building a dollhouse, or learning new card games.

References

1 The web site of the Loka Institute (www.loka.org) is a good resource for citizens interested in more democratic approaches to science and technology policy.

Chapter 8

Technology Literacy Guidelines for Teachers and Teacher Education*

Limited by their own notions of technological optimism and determinism, many technology enthusiasts forget that learning is first a transformation of the mind and heart of the learner. The younger the learner, the more the need for unmediated exchange and interaction between teacher and learner, between learner and learner, and between learner and content. Filling the child with a clutter of educational technologies is a wasteful exercise at best, and toxic to the growth and transformation of the learner at worst. Technology in teacher education must be a mindful practice that is integrated with the highest principles of teaching and learning.

* This chapter was drafted by Muktha Jost, assistant professor in the School of Education, North Carolina A&T State University, and a member of the Alliance for Childhood's Technology Literacy Roundtable.

This chapter provides a plan for developing a more thoughtful and socially responsible approach to technology literacy in teacher education programs. Its three sections offer guiding questions for teachers in schools of education; specific concepts that need to be understood by teacher candidates in order to develop a capacity for technological literacy (with references to a few useful teaching materials); and suggestions for a technology literacy curriculum.

Guiding Questions for Teacher Education Programs

What is "educational technology"? Just as engineers learn to employ appropriate tools within the framework of their own inventions and designs, doctors in the practice of healing, and artists in the pursuit of artistic expression, teachers too must be educated about the tools that can help them in the work of teaching and learning. Whether the tool is a chalkboard, an abacus, or a virtual reality cave, a clear goal of instructional technology education for teachers must be to prepare them to make the best

choices for the learner in the intended environment.

A course in educational technology ought to begin with a creative exercise on the definitions of technology, technology literacy, and educational technology. For example, any tool, technology, process, or product that a teacher can bring into the classroom for the purpose of teaching and learning is a part of educational technology, but technology literacy goes far beyond the tools themselves. It includes our attitudes toward those tools, the way those tools influence us and society as a whole, and the skills necessary to use the tools.

What is "technology literacy"? The tools of the science teacher and the social studies teacher may vary, and the elementary teacher may use tools different from those of the high school teacher, but they all need to be informed and inspired by the same understanding of technology literacy. The Alliance for Childhood proposes the following definition: Technology literacy is the mature capacity to participate creatively, critically, and responsibly in making technological choices that serve democracy, ecological sustainability, and a just society.

The old picture of technology literacy focused mainly on skill and competence in using machines. The new definition focuses on teachers' and students' creativity, critical judgment, and ethical responsibility. In order for teachers to play active roles as creators, critics, and responsible users of technology, much more than skill in using technology must be cultivated. We must cultivate the full range of human capacities.

Have classroom computers lived up to the promises made about them? The simple truth is that computers were oversold and have under-delivered. The general failure of computers as instructional tools is not totally the fault of the computer, but of our lack of understanding of child development and of the problems facing public education today. We failed to look back at the history of educational technology and have a frank conversation about gains and losses. If we had, we would surely have heard the overoptimistic stories that accompanied every innovation in educational technology—books, radio, television, slide projector, and, of course, the computer—and how those technologies failed to solve the complex educational problems we expected them to solve.

There was never a very clear reason for our full-scale implementation of the computer curriculum, other than a vague sense that we must prepare students for a high-tech labor market and the assurances of technology proponents that this was a surefire way to help students develop critical thinking and problem-solving skills. We set about the costly task of putting computers and labs in place, adjusting the computer-to-child ratio (which is now far better than the teacher-to-child ratio), training teachers to use computers and integrate them in the curriculum, and equipping children with the skills to use computers. Yet even when teachers can boast of "success variables," like access to computers, the best professional development, tech support, extra time, and motivated students, they are not able to justify bringing the computer to center stage on the basis of its pedagogical role, as experts once promised. This has more to do with how the stage was set rather than the worth of the computer itself.

What is the proper context for technology literacy? It is best for teacher candidates to evaluate each tool in its context through direct experience. It is, however, important to put the concepts before the software and its dazzle. Educational technologies should enhance the profession of teaching, not stifle it through misdirected technological optimism. For instance, far too much emphasis is placed on creating spreadsheets and databases and too little on applying the mathematical concepts of probability, scale, and estimation. Too much time is spent on generating videos, animation, sounds, and multi-

media fantasies, and too little on visual literacy principles and the message of the medium. Proficiency in these tools must include the ability to read, understand, and critique such displays of data.

Teacher candidates need more than a one-semester course in technology literacy to develop the knowledge, skills, and outlook required to take part in the education of children.

Aspiring teachers should become aware of the disconnect in schooling among teachers, learners, and curriculum creators. Children of color now make up more than half of the U.S. public school population, but teachers and curriculum creators remain predominantly white. One of the paradoxes of technology is that it actually creates distance between and disconnects people even as it promises to connect them. This paradox takes on a sinister life in classrooms where standards-based instruction, scripted instructional programs, and standardized assessment have already distanced teachers from their students.

Even as teachers are introduced to the massive potential of technology to create, store, and display data, they should reflect on the abilities and limitations of the human hand, heart, and mind in assimilating and synthesizing information in gargantuan amounts and the corresponding implications for children's learning. Similarly, competency in creating multimedia presentations using digital and internet technologies should be informed by a deeper understanding of the grammar of visual literacy. Popular media like movies, novels, TV and print commercials, and music all include numerous opportunities for analysis of technological principles.

What is my philosophy of education, and how does technology fit into it? When technology education is merely the pursuit of skills in using the latest tool, then the means become the end. The highest goal of human innovation is to honor and protect life through a democratic and socially responsible process; this end needs to be re-established in the realm of education and educational technology. Teacher candidates must be encouraged to reflect on their own beliefs about education and teaching, and use that as a context to evaluate appropriate tools. Inherent in this philosophical inquiry is a recognition of the diversity of students' lives.

Technology literacy includes our attitudes toward tools, the way those tools influence us and society as a whole, and the skills necessary to use them.

The best time for technology education is after the teacher candidate is able to articulate a philosophical statement about teaching and learning that reflects the complex nature of the profession. This is especially crucial because of the potential of technologies to alter the teaching and learning context. Because technologies always narrow the range of human thought, placing attention on educational technologies too early is likely to shape rather than merely reflect the candidates' understanding of what education is about. Most teacher education institutions and accrediting bodies are now struggling to integrate revised theories and definitions of intelligence and learning styles. The potential of any technology must be weighed in light of these new definitions—not determine them.

Teacher candidates should learn to ask questions that give them a living picture of their students: What do their neighborhoods look like? What is their family structure? What do I know about how these students learn? What are they likely to do in the summer? Who do they like to hang out with? What activities are they naturally attracted to?

One of the paradoxes of technology is that it actually creates distance between and disconnects people even as it promises to connect them.

What do they enjoy about my teaching? Would they come to me if they had a problem? Do they get support for schoolwork at home? Do they have computers at home? Internet access? How many hours of TV do they watch? Can I tell a story about each of my students?

The goal of activities like this is to get teachers to evaluate their connections to their students, to the curriculum, and to themselves, and then to design lessons that can address the links among the three. Once teachers get a glimpse of their students' developmental readiness and needs, it takes far less time to evaluate the tools, like the computer, to communicate the curriculum to them. In addition, it also helps the teacher understand that developmental needs are in constant flux, calling for the teacher's continued attention.

During one such activity, teachers in a technology education course realized that many of their students were claiming to have computers at home just to appear "cool" or to avoid looking poor in the affluent school to which they were bused. Insights like these are powerful to a teacher interested in understanding social inequities and how they affect learning experiences.

What are my curricular goals, and how does technology relate to them? The pediatrician's tools are different from those of the skin specialist or the cardiologist, despite their common field of medicine. This distinction is necessary for teachers, too. The technologies that can assist a teacher of third-graders learning money concepts are vastly different from those appropriate for a high school teacher aiming to teach soil tilth concepts or environmental science to ninth-graders.

Teachers should think deeply about the content they are planning to teach and identify a part of the curriculum that poses a challenge. Most teachers have rough spots, slippery slopes, and mountains in their curricula—places that are especially difficult for them. They tend either to spend more time and energy in those areas, to gloss over them, or to avoid them altogether.

How does technology fit the developmental needs of teacher candidates? Courses on integrating technology in the curriculum are often based on the premise that if you provide the computer lab and the software to the students, they will learn. This leads to mismatched teaching practices, assignments, and assessments. It is now customary for students at all levels to produce PowerPoint presentations, mini-videos, and web pages that are only remotely connected to learning goals. The dazzle of the technology rather than the quality of the content earns them the grade.

The push for technology in schools had little to do with the needs of children. For instance, acceptable use agreements covering copyright and legal issues involving technology are often adopted across the board and imposed in a vacuum without connecting them to the stages of a child's moral development and the child's ability to make moral and ethical choices. National technology standards that are pushed on children through teachers show little regard for the cognitive, physical, personal, and moral development of the child. They require abstract thinking of children who are in their concrete stages of learning.

Technology tends to nudge any curriculum toward a technical dimension, which explains the focus on skills when it comes to educational tech-

nology. Skills alone provide no inherent moral or ethical direction. Thus, in any educational technology curriculum technical skills must be re-examined and integrated into previously developed knowledge and attitudes (which do have moral and ethical dimensions) about teaching and learning.

An unintended consequence of standards-based teaching of technology literacy is that we've ignored the developmental needs of teacher candidates, even when it comes to skills. Teacher candidates bring with them a very basic exposure to technical skills, compared with students prepared for careers in engineering and science, and often unexamined worldviews about technology in general. Thus, rigorous skills-based standards are mostly ineffective in helping teacher candidates become technologically literate.

Whose voice is heard in technology literacy standards and policies? Decisions about the adoption, placement, and integration of technology in schools have generally been made without much attention to teachers' voices. Teachers are being judged on their efficacy in integrating a tool that they did not choose to employ. In order to have teachers exercise their voice in decision-making about technology, a more comprehensive, relevant, and powerful education in technology literacy is essential.

A teacher's effective use of tools and technologies rests on an understanding of the technology plans, mandates, and imperatives of the school, district, and state. Teachers should be able to gather and understand this material through site visits, face-to-face interviews, and research, and to engage in a critical, comparative study with their peers. An integral piece of this study is to explore the issue of cost. Who is footing the bill? What kinds of spending are not taking place in order to pay for the technology? Are teachers' voices heard in the process of making these decisions?

The student-to-computer ratio is often used as an indicator of equity. But this ratio has little to do with equity. Teacher and administrative turnover in Title I schools, the lack of technical support or high-quality professional development for teachers, and the social and professional status of parents all point to a huge disparity in education between the educational experiences of white or Asian students and African-American or Hispanic-American students.

Can technology transform teaching? Limited by their own notions of technological optimism and determinism, many technology enthusiasts forget that learning is first a transformation of the mind and heart of the learner. The younger the learner, the more the need for unmediated exchange and interaction between teacher and learner, between learner and learner, and between learner and content. Filling the child with a clutter of educational technologies is a wasteful exercise at best, and toxic to the growth and transformation of the learner at worst. Technology in teacher education must be a mindful practice that is integrated with the highest principles of teaching and learning.

Building Technology Literacy in Teachers: Founding Concepts

Building the capacity of teachers to become technologically literate involves an understanding of the history of technology and some key concepts like technological determinism, amplification and reduction of technology, unintended consequences, non-neutrality, and technological optimism. This takes time. But well-chosen materials, combined with discussion, activities, and other assignments go a long way toward helping teachers ask the right questions.

The fact that technology solved some pressing problems in the 19th and 20th centuries opened the door for the pervasiveness and adoration of technology today. Teacher candidates need to explore technology's ability both to solve and to create problems. Unless teacher candidates are

aware of current social and ecological problems, they cannot measure the role of technology in alleviating or worsening those problems.

Teach the history of technology. Mindfulness comes naturally out of an understanding of technology's history, potential, and paradoxical nature. Although it's impossible to trace the development of all the important technologies, a few (especially information technologies) should be explored with teacher candidates to establish the power of technology as an agent of change. Any skeptic has only to look at the supermarkets, banks, libraries, schools, airlines, hospitals, and military services from a decade or two back to understand the immense cultural, social, and political changes wrought by the computer.

The following questions can guide such an exploration: What need led to the development of the technology? How was it developed? Who were the people involved? What clues can we get from the lives of the inventors and innovators who shaped the development of the technology? What purpose was the tool or technology originally intended to serve? What purposes does it serve now? Who paid for the development of the technology? Who benefited? Who lost? What are the short- and long-term risks associated with the technology? How does the technology affect me, my family, my community?

Explore these questions in relation to television, the wheel, the airplane, nuclear weapons, antibiotics, contraceptives, game technology, or the telephone.[1]

Discuss the unintended consequences of technology. The book, the educational film, and television were each hailed as the ultimate educational technology that would revolutionize teaching and learning.[2] The predicted revolution never happened, but other unintended consequences did. For instance, the proliferation of texts made possible by the invention of the printing press brought about a shift in the classroom from oral exchange and interaction between teachers and students to a focus on the more abstract written word. The development of television led to a culture of entertainment and consumerism that engulfs even the very young. Philo Farnsworth, one of the inventors of television, became one of its most vehement critics. He came to feel he had created a monster—a way for people to waste much of their lives. Teacher candidates can sense the scope of unintended consequences as well as the power of choice when they learn the story of Farnsworth.

Teach non-neutrality as a feature of technology. Educational technologies are not neutral. They are selective in the senses, experiences, cultural patterns, and ideologies that they amplify. They have ingrained in them the hopes, interests, ideas, beliefs, biases, and ways of solving problems of their creators.

Understand the role of technology in the shaping of society and the classroom. The principle of technological determinism is nowhere more evident than in the introduction of the computer in schools. The common belief is that the computer was invented and introduced into society, and has now taken on a life of its own in education. But deliberate choices were made at every step of the way, to fund computer labs and the wiring of schools, the training of teachers in the integration of technology, the creation of jobs for computer and telecommunication specialists in schools, and the research on computers as a teaching and learning tool. It is important that teacher candidates study this trail of decision-making and identify the questions that were asked, the ethical issues that were involved, and the consequences of those decisions.

If a teacher is to prepare students to make socially responsible choices regarding technology, then the teacher should know the ways in which technology shapes human history and people shape technology. Technological determinism is one of

the most difficult concepts to teach, but an effective way to make this concept transparent is to use historical perspectives and timelines. Even some of the simple technologies led to major changes in human history, but the direction of their growth was influenced by human choices and unintended consequences. Good examples are navigational instruments (leading to Europe's colonization of much of the world), the printing press (leading to the Reformation), Eli Whitney's cotton gin (contributing to the resurgence of slavery and ultimately the Civil War), and the birth-control pill (leading to the sexual revolution).[3]

Teacher candidates can learn much about technology literacy through exploring popular educational technologies including writing implements, the abacus, books, slide projectors, overhead projectors, printers, display boards, dioramas, audio lessons, distance learning, and virtual reality. What kinds of learning goals can these technologies address? How appropriate are they to the maturity level of the learner? How do they affect the learner? What knowledge do we need in order to make ethical choices involving the use of this technology?

Teach what technology amplifies and what it reduces. A concept related to technological determinism is amplification-reduction, the idea that the use of technology always amplifies some aspects of human life while it reduces others. The fundamental truth that leads to this condition is that all technologies (both processes and products) are extensions of the human body and mind. The market push for classroom technologies is another factor that makes it imperative for the classroom teacher to understand the benefits, risks, and costs involved in using any form of technology.

Consider the roots of technological optimism. Technological optimism is ingrained in the modern mindset, and stems from core Western values of technology as a means of controlling nature. This belief is behind many short-sighted decisions regarding technology. Politics has shaped educational technology: the focus on training during and after World War II leading to instructional design technologies, and the focus on the internet and wiring schools during the Clinton era. The administration of George W. Bush has identified testing as an area for effective use of educational technology.

Even as teachers are introduced to the massive potential of technology to create, store, and display data, they should reflect on the abilities and limitations of the human hand, heart, and mind in assimilating and synthesizing information in gargantuan amounts and the corresponding implications for children's learning.

Anyone who takes a critical perspective on technology will be labeled old-fashioned, a laggard, or a Luddite. This labeling often pushes teacher candidates away from asking questions, or toward resisting technology without gathering the relevant information. A teacher candidate questioning the potential of computers in teaching should be treated with the same respect as one figuring out nutrition labels on food.

Materials for Teaching Founding Concepts of Technology Literacy

"Ecological Design: Inventing the Future." This video presents dazzling possibilities for a new vision in technology literacy based on maintaining a dynamic balance among nature, culture, and technology. It calls for a shift in our values and beliefs away from a market perspective and toward fair and resilient living systems based on optimum use of resources.[4]

It is full of examples of inventions that are technologically smart and socially responsible. It also

presents the possibilities of technological innovation and growth based on democratic principles of sustainability, universal access, cost efficiency, and shared progress.

"The Gods Must Be Crazy." The first scene of this movie is a good tool for widening students' definitions of technology to include cultural heritage, human interconnectedness, and relationship to the environment and the world.

The film shows the bushmen of the Kalahari desert embodying the definition of technology literacy. They have the capacity to explore new technologies and evaluate their worth based on how well they serve the needs and priorities of the community.[5]

"Ancient Futures: Learning from Ladakh." This video, based on the work of Helena Norberg Hodge, tells the story of the Ladakhi people who live an isolated but comfortable life in the harsh Himalayan landscape with scant material comforts. It's the story of a community at peace with itself and the earth on which it depends. In the mid-1970s, development, industrialization, and Western notions of progress descend on this community like an avalanche primarily because of the introduction of a single technology: roads.[6]

All three of these videos demonstrate the principle of setting limits and making technological choices.

Creating a Technology Literacy Curriculum

Reestablish value for the natural order of the world around us. The usual technology curriculum in teacher education consists of technique-oriented how-to units on academic and administrative software and digital technologies. Competencies are often assessed and evaluated through multiple-choice tests, "techie" projects and portfolios, and isolated lesson plans showing evidence of technology integration. The discourse on educational technology is limited to computers. The common classroom scene has scores of computer stations with teacher candidates engrossed in mastering the skills of searching the internet, designing a spreadsheet, or creating presentations with visuals and sound. Teacher candidates are then expected to take these tools and "integrate" them into their teaching and classrooms.

The natural world and its people came before technologies, which emerged because people attempted to solve problems. The proliferation and pervasiveness of technologies in almost every aspect of our lives takes this natural order out of context and leads us to believe that we are led by our technologies. But the ubiquity and complexity of technology can be used to demonstrate that the real world came first.

Both teacher educators and teacher candidates should engage in activities like "The Naked City."[7] Its purpose is to imagine what is left after removing everything provided by technology in a large city: very little. Not only does this activity make everyday technologies more transparent, it also highlights the natural world and people as the first priorities. Teacher educators also establish this priority when they model the use of a technology to further human communication and understanding.

Recognize and respond to the pervasiveness of technology in students' lives. Teachers should reflect on the increased role of technology in the lives of children as an ecological issue. How does increased technology use outside of school affect other aspects of students' lives, from recreation to relationships to classroom discipline to academic performance to ethical decision-making abilities? What should the teacher's response be to those influences?

While some students are saturated at home with entertainment and communication technologies, a significant number of students lack consistent access. A part of the education of teacher candidates should include an inquiry into the nature of

access for their students. Decisions about using sophisticated educational technologies either for teaching or communication with parents must then be based on this knowledge.

Understand the risks technologies pose to human beings, especially children. Teachers also need to understand the physical, social, and emotional risks to children associated with technology use. This knowledge should be gathered in the context of the real-life situations of the children. Action research activities that focus on observation of computer labs with children and/or adults in both instructional and noninstructional settings, real conversations with children on their technology engagement, research reports in popular media on consequences of technology engagement, and mindfulness of technology in their own lives are all effective strategies in getting teachers to understand the many dimensions of technology use.

Very few people who signed on to use the internet had any idea of what lay in store for them: pornography, pop-ups, spyware, and adware. These unintended consequences cause major problems. Similarly, few early users of the automobile would have foreseen its future effect on health and the environment through our dependence on oil.

Teacher educators have a responsibility to help teacher candidates understand these issues. An example: If students are asked to learn how to create animations (which have very limited instructional value), the curricular material available is extensive—textbook chapters, manuals, software manuals, online tutorials, instructional web sites, freeware, etc. But for teachers trying to understand the developmental risks to children posed by computers there are few available resources. One of the few is the Alliance for Childhood's 2000 report, *Fool's Gold: A Critical Look at Computers in Childhood*. Students can read that report and then complete an action research activity that requires observing a computer lab during instructional or noninstructional time.

Start with noting the basic availability of computers and peripherals, degree of access in the lab, and what kind of help is available. Then proceed to the following tasks, answering questions through careful observation:

- Describe and sketch the lab arrangement (furniture, lighting, ventilation, cords and wires, traffic pattern, handicap access).
- Describe the posture of computer users.
- Observe the "fit" between users and work stations. Are keyboards set at the right level? Monitors?
- Are computers arranged side by side or front to back? What is the distance between stations?
- When were the monitors manufactured?
- Is the furniture adjustable? Are children using the adjustable features?
- Describe how engaged the computer user is. What is the concentration level?
- Is fluorescent lighting dimmed to reduce glare? Are blinds closed?
- What is the distance between the student and the monitor?
- Do children look directly ahead, down, or up at the monitor? If they are looking down or up, at what angle?
- What is the temperature in the lab?

Through this activity, teachers become more aware of their own posture in front of the computer and the time they spend with it and engage other teachers in conversation about developmental risks regarding technology.

Understand and be able to apply visual literacy principles. Educational technology has been promoted as a great motivator for learners. How long a child (or adult) stays engaged with the computer is often tied to the visual element of the medium, which has implications for learning styles and preferred sensory gateways for receiving and decoding information. This makes the teacher's knowledge of

The general failure of computers as instructional tools is not totally the fault of the computer, but of our lack of understanding of child development and of the problems facing public education today.

visual literacy especially important in evaluating the appeal of any educational technology. Understanding the mental skills evoked and developed by processing images as compared to text will also help teacher candidates recognize the cultural influence of various technologies on children.

Discuss the changes brought about by new technologies in the classroom. Provide teacher candidates plenty of opportunities to study the nature of learning contexts that are rich in technology and those that are primarily human-centered. The educational technology classroom is the best place to conduct these experiments. Design environments ranging from robust face-to-face discussions to lessons taught, discussed, and graded online. Encourage teacher candidates to observe computer lab settings that are both instructional and noninstructional. Have them observe communication patterns among students and teachers, physical arrangements, the content being studied, lighting, level of interest, and motivation. Encourage teacher candidates to look at their own use of computers, cell phones, TV, cars, pagers, and palm pilots.

Be able to think about and with technology. This includes fluency in the language of technology, especially educational technologies. The common practice in educational technology courses of having students master software and internet tricks shortchanges this essential goal. No more than a third of the course time should be devoted to achieving mastery over skills, software, and machines. How do you know what you know about technology? is a simple but important question to ask of teachers.

The pervasive use of advanced technologies and their low cost have reduced hands-on experiences for children, including the simple but overwhelmingly rewarding experience of taking things apart and putting them back together. Without this, technology becomes a mystery, leading to a perspective that might well be called "magic consciousness." This consciousness is a perversion of the magical enchantment that naturally pervades a child's world and is too quickly destroyed by adult insistence on viewing the world mechanically.

In order to limit the potential harm done by educational technologies, teacher candidates should understand all of the following: online dangers for children; the pervasiveness of false or unreliable information online; the tendency for online research to encourage plagiarism; cultural, ethnic, and economic inequities; gender inequity.

Encourage teachers to ask brave questions regarding computers:

- What is the story of this technology? What did it promise? What did it deliver?
- Who makes the decisions related to this technology?
- What values does this technology foster in the classroom?
- How complicated is the use of this technology?
- How does it affect the socialization process?
- What effect does it have on simpler technologies?
- What are its aesthetic qualities? How does it look? Is it noisy? Does it drown out human sound? Does it require a change in natural lighting patterns?
- Who pays for the purchase, installation, and maintenance of the technology?

Demonstrate the power of taking things apart by having teachers "dissect" a computer in class. Tutorials from the web are a great source for visual representations of the inside of a computer. Have teacher candidates hunt for the different parts. The leaps that they will make in their level of comfort with the machine are worth the hassle of salvaging some computers for the take-it-apart exercise.[8]

Understand basic engineering processes of design and innovation, and how they are tied to human needs and wants. The common worldview regarding technology is one of surrender. Teachers and students often have an unquestioning acceptance of the computer as a tool in teaching. This is not to say it's a welcome acceptance. While some teachers falsely transfer their feelings of efficiency from being fluent users of the computer and the web to that of a teacher integrating technology in teaching, some fear the computer, and others simply resent it. Most teachers and students, however, raise no questions about the rationale for the computer and whether they have the capacity to use it in ways defined at the beginning of this chapter.

In *Technically Speaking* the authors explain the need for technologically literate citizens to understand the engineering design process, engineering concepts like systems, and the innovation process behind engineering.[9] To understand systems is to understand the power of human needs and wants on one hand and the limitations of human innovation on the other. A lesson in systems can actually help teachers assign the computer its rightful place in pedagogy. It can also teach us humility in the process of education.

In the engineering context, systems refer to different components that work together to provide a desired function. Systems can range from simple to complex, with few components (the ballpoint pen) to millions of components (the computer) to millions of components assembled in hundreds of subsystems (the commercial jetliner). One kind of system that is closer to the system of education is one that is diffused geographically, like the transportation system, with its roads, bridges, tunnels, gas stations, and airports.

An understanding of systems can help teachers examine their own attitudes toward technologies, which often provide an illusion of control. In the example of the transportation system, teachers are able to see the role of human needs, desires, beliefs, and efforts at innovation with their flaws and limitations. It also helps them see the computer as just one item on a menu of tools that can facilitate the process of teaching and learning specific curricular material.

References

1 An effective teaching strategy is the creation and use of photo essays that provide a visual depiction of the technologies, their history, the people associated with them, the opportunities and risks, and their effects on society and culture.

2 Paul Saettler, *The Evolution of American Educational Technology*. Englewood, Colorado: Libraries Unlimited, 1990.

3 Merritt Roe Smith and Leo Marx, eds., *Does Technology Drive History? The Dilemma of Technological Determinism*. Cambridge: M.I.T. Press, 1994.

4 Chris Zelov and Phil Cousineau, producers, "Ecological Design: Inventing the Future." Knossus, Inc.

5 Jamie Uys, director and producer, "The Gods Must Be Crazy." 20th Century Fox, 1981.

6 John Page, producer, "Ancient Futures: Learning from Ladakh."

7 National Academy of Engineering, *Technically Speaking: Why All Americans Need to Know More About Technology*. Washington, D.C.: National Academies Press, 2002, p. 48.

8 Two useful web sites for this activity: http://computer.howstuffworks.com/pc.htm and http://www.kids-online.net/learn/click/table.html.

9 National Academy of Engineering, op. cit.

Chapter 9

Questions and Answers About Children and Technology

Most of us have some deep-rooted ideas about tools, based on our culture and our own background. One of them is our perspective about whether we make tools to serve human needs or whether we make tools to realize an exciting technical possibility and then look for some need it can help us meet—or create one. Is it the human for the tool or the tool for the human? It's time we consciously focus on our values and our goals in making technological choices.

At what age should children be introduced to computers?

There is no magic "right" age at which children "should" be using computers, so we make no claim to having a definitive answer. We urge caution, however. Computers involve advanced technologies designed for adults with complex needs for managing information—not for children, whose needs for whole-body, hands-on, and face-to-face learning experiences are just the opposite of what computers offer.

A major motivation for placing computers in the classroom appears to be a concern that children be prepared for the jobs of the future. Learning the technical skills required for most entry-level jobs is hardly rocket science. Practically speaking, they can be amply covered in a single course or two in high school. Teachers and librarians working together might also choose to introduce middle-school students to the use of the internet as one of several resources available in libraries for research projects. High school is a good time to teach computer skills and to help students examine comput-

ers, video equipment, cell phones, SUVs, and other common contemporary technologies as objects of study in their own right. That includes studying both the basic science and engineering of how they work and their broad range of social, political, health, and ecological effects, both positive and negative.

Most children, from infancy, will see adults operating computers in a variety of places—at libraries, banks, stores, and offices, and at home. That's actually a very healthy form of first exposure, as long as the machines are not distracting the adults from paying attention to children or to each other. Children invariably love to imitate adults, and may well show an early interest in "playing computer." But we would not mistake a preschooler's fascination with fire trucks as evidence that it's time to sit her behind the wheel of a real hook and ladder. Curiosity about computers and other powerful technologies is not a sign that a child is developmentally ready to operate the real thing. We are far more likely to help children grow intellectually by letting them create their own "pretend" computers, powered by their own imaginations, than worrying so much about how soon children need to operate one of these powerful machines themselves.

How about children with disabilities? Do you want to withhold computers from them?

For a children with a special disabilities for which computers have been shown to provide some compensation, it would be cruel and foolish to deprive them of access. However, even here some judgment must be used. If the disability is remediable—if it can be corrected through social, educational, or psychological means—then providing a computer at a very young age to compensate for the problem may inhibit that process of growth. Before making the decision about substituting a computer for cognitive or physical skill, one must first determine whether the current lack of skill or ability is permanent or not, and whether the computer will take the place of an ability that could, with effort and aid, eventually be developed within the child. It seems cruel to us to deny a child the development of her inner capacities by substituting an external tool for them just because it may take more effort or time, or more long-term expense, to help her attain them herself.

Is there any harm in doing computer activities together with my young child? He enjoys it so much.

Children enjoy many activities that are not especially beneficial, such as drinking sugary soft drinks, trying out professional wrestling moves on their younger siblings, or riding bikes down steep hills without helmets. They also, of course, enjoy many things that are healthy, including having parents hold them close and read their favorite books with them, puppet shows, fingerpainting, digging for worms, constructing elaborate outdoor hideouts, and so on. Adults have always had to exercise judgment in steering children toward enjoyable activities that are also in some way beneficial or at least harmless.

There is plenty of evidence now that television, which leaves no cuts, scrapes, burns, or bruises on a child, is nevertheless potentially quite harmful to a small child's healthy development. There is a growing body of anecdotal evidence of similar harmful effects from the computer. It may seem that a few minutes a day on the computer in early childhood could hardly do lasting harm. Still, operating computers and other advanced electronics require a kind of analytical and abstract thinking that may interfere with young children's more concrete and flexible ways of perceiving and interacting with the world.

Reports from parents suggest that when children start very young, they tend to become increasingly

fixated on computer games or surfing the internet. If parents themselves initially introduced the child to computers, they may feel conflicted about trying, when the child is older, to limit what has become an excessive habit.

Young children love to imitate their parents and teachers. But a young child is often quite happy *pretending* to fry eggs, climb a high ladder, play office, or drive to the grocery store. Why should their imaginations fail them here? Encourage them to pretend.

Won't my child fall way behind other children if I restrict his learning to use computers?

Not really. He will fall behind understanding how to operate programs and machines he's unlikely to encounter as an adult anyway, given the pace of technological change. But he won't fall behind learning how to communicate with and get along with others, what his community is like, an appreciation for nature, or the proper role of tools in his life. While other children are being encouraged to learn soon-to-be-obsolete computer skills, he will have the opportunity to focus instead on these lessons that are far more fundamental to success in school and happiness in life.

The important thing is that the choice is not between learning via the computer and not learning at all. Multimedia computer programs often look impressive simply because current textbook- and standardized-test-driven teaching is so sterile and ineffective. In the long run, we will have to worry about children falling behind only if we allow education to be defined by what can be learned through a computer.

What should schools require every high school student to know about technology before graduating?

Any answer to this question should take into account the context of a particular student's life.

We would not mistake a preschooler's fascination with fire trucks as evidence that it's time to sit her behind the wheel of a real hook and ladder.

Schools should offer all students the opportunity to be skilled in typing, in using a word processing program and the internet, and in the general operations needed to manage a desktop computer system. Other computer skills that many students will find useful to learn either in high school or college include basic database, spreadsheet, and bookkeeping skills, and some desktop publishing skills, as well as the basics of putting together digital slide presentations and web site design. All of these can be helpful in the modern workplace but are in a continual process of change. Perhaps the most important thing they should know is how to follow directions from a manual (along with the imaginative creativity to depart from it when, as is so often the case, the manual proves inadequate).

Students should also understand the fundamental scientific and engineering principles, in a very basic way, behind the operation of the range of technologies—from simple to complex—that they commonly encounter. They should know, for example, the basics of how electric lights and motors, televisions, combustible engines, telephones, stereos, and computers work. But they should also understand, in a very simple way, the mechanical underpinnings of such basic technologies as flush toilets, kitchen plumbing, carpentry, and how to change a flat tire.

Beyond those technical skills and knowledge, students should leave high school with an appreciа-

Students should understand the fundamental scientific and engineering principles behind the operation of the range of technologies—from simple to complex—that they commonly encounter.

tion for the complex historical, social, political, ecological, and psychological roles that technologies have played in human life. They should recognize that all technologies are double-edged swords. They should also be aware of the differences between direct engagement with the physical world and experience that is mediated by tools. And they should have had opportunities to discuss and debate how technologies relate to current issues and problems.

What can concerned parents do when computer use by young children is mandated by school, district, or state?

Certainly the most important thing to do is to register one's concern. School administrators are just as susceptible to the commercial hype about technology as parents are. They often assume that parents expect computer use in the classroom. If they begin to hear from parents voicing concerns, they may slow the pace of implementing such a policy—after all, it is a severe drain on scarce resources. They may also become more open to reading critiques of educational computing for children, such as the Alliance for Childhood's *Fool's Gold: A Critical Look at Computers in Childhood*, Todd Oppenheimer's *The Flickering Mind*, Jane Healy's *Endangered Minds*, or this report.

Parents who organize, prepare themselves, and initiate a dialogue in school communities have a chance to make a real impact on this issue. We suggest that parents give a copy of both *Fool's Gold* and this report to administrators of schools that their children attend. Talk to other parents—you will find that many have been quietly nursing similar doubts. Bring it up at PTA meetings. Get a discussion of the issue on the school board agenda. And raise the issue politically, as many candidates for school boards may be unaware of the evidence on the benefits and drawbacks of educational technology. Get other parents thinking and talking about this issue.

Meet with your own child's teacher and express your concerns. You may ask that your child be exempted from computer activities, though one must gauge the strength of your child in dealing with the possible social ramifications of standing apart from the crowd concerning an issue she may not fully understand. It would be far better if you could find other parents to support you. You may even find some allies in the teaching ranks. We have heard from many teachers who are unhappy about how much they must emphasize computers but find that parents insist on it. Hearing parents express concern may be a great support for such teachers.

What can a teacher do when computer use by young children is mandated?

Teachers too can organize in schools, districts, and on a state and national level to advocate for a new look at this issue. This is especially true in schools with site-based management that includes teachers in key decisions.

Mandates of ill-advised policies are nothing new in U.S. public education. And teacher resistance to the pendulum swings of public education policy is a long and valuable tradition. As individuals, teachers may not be able to ignore mandated computer use, but they can temper it. They can minimize usage on the one hand while compensating for its

presence on the other. They can be careful not to generate assignments that compound the problem by requiring computer use at home. Like parents, they can see to it that the experiences not provided by the computer are given emphasis in other aspects of school life. They can promote the principles articulated here in a variety of innovative classroom (and out of classroom) activities. They can discuss their concerns with other teachers and parents and distribute materials like this report that challenge the assumptions about educational technology. And they can make careful observations of the impact of infusing computers into the classroom to document for supervisors and colleagues the specific examples and experiences that give rise to their concerns.

What's the best age for learning keyboarding skills?

There doesn't seem to be a definitive answer, from the point of view of developmental readiness. What is clear is that when students learn keyboard skills they should learn them well, for it is very hard to correct poor keyboard habits later. It is also important that they learn good posture and health habits—such as taking frequent breaks—to prevent repetitive stress injuries and eyestrain.

At what age is it okay for a child to have a separate e-mail or instant-messaging account?

Again, there is no simple answer. We suggest that high school is the time for students to begin instant messaging and e-mailing, and that, at least for the first six months, adults should closely monitor these activities. This can be done in an open and matter-of-fact way, in the presence of the students themselves, so that they experience this as face-to-face adult guidance, not spying. The message to convey is that online communication is a powerful technology, in terms of its potential social impact, positive and negative.

Online communication involves a level of judgment and maturity that should not be expected even of young teens. People can be, and many have been, emotionally scarred by the speed and range at which harmful messages can be broadcast and rebroadcast, entirely out of the control of the original writer's intention. One's privacy and even physical safety can be endangered. Just as you would expect your children to introduce you to their friends, it is reasonable that they tell you with whom they are communicating online, and the general context of that communication.

Until you have evidence that your child can handle the threats and risks of online communication—including the constant barrage of spam urging them to check out pornographic and anti-social web sites—she will benefit from being monitored. We also agree with the advice of the nation's leading authorities on children's health and development: home computers should be in places where the whole family congregates, not in children's bedrooms.

If you decide to let younger children have their own instant-messaging or e-mail accounts, pay close attention to whom your child is communicating with and the content of their messages. In their presence, go through their buddy list for instant messaging, for example, and make sure that they know each person well enough for this kind of contact. Set strict time limits for this activity so that it does not replace more challenging and ultimately more rewarding social exchanges.

How can I prevent my child from being exposed to violent video games and movies if all of their friends have them at home?

Sad to say, short of locking him in his room all day, it is next to impossible to fully protect your child from such exposure. You can diminish this exposure, however, by welcoming your child's friends into your home and offering lots of

alternative things to do. Help your child develop a love of nature, the arts, and the outdoors. It is important, too, that your child has wise and loving adults to return to after encountering violent videos and movies. There is some evidence that exposure to violent screen images is less crucial than how those images are interpreted—that having an adult around to interpret those scenes helps lessen their destructive impact. So it is crucial that you be available and open to discussing what your child has seen when he encounters these images.

Children are not ruined by occasional exposure to violent games and films. Have faith that the love and peacefulness conveyed over the years in your home will offset the destructive forces your child will find outside of it. On the other hand, if you find that your child is extremely sensitive to on-screen violence, as some children are, you will have to make greater efforts to protect him. Think of the steps you would take if your child had a serious allergy. He would need to know how to protect himself from eating the harmful food and you would need to tell the parents of his friends about his allergy. You may need to provide this extra protection if exposure to violence leads to nightmares, a fixation on certain images, or other signs of deep disturbance.

Organize with other parents and teachers who share your concerns. Parents can monitor their own children's purchase and use of objectionable games. And consider taking your concerns to local stores that are willing to sell the most anti-social of these games, especially if they allow children to purchase them.

Hasn't the internet made the traditional ways of doing library research obsolete?

Not at all. The internet is a wonderful resource. Judging the quality of what one finds, however, requires a level of intellectual maturity and critical thinking that is still developing even in late adolescence.

When young people are introduced to the internet they need support and mentoring in distinguishing credible sites from less reliable ones. A simple rule of thumb is that if they are too young to make such judgments then they are too young to use the internet by themselves.

Few people realize that there is very little good research available on the internet that predates the development of computer databases. That means it's hard to find much research material online that was written before the 1980s. A great deal of knowledge existed before then, much of it available only in print form, usually archived in real libraries. Giving students the impression that the internet is all they need to do research essentially encourages them to accept the idea that nothing written before the computer came along is important (if they know it exists at all).

The dream of putting everything in the Library of Congress online is now, and is likely to forever be, a dream. The contents of many of the most reputable publications are not available for free on the internet, and even access through libraries' paid online subscriptions is often quite limited. The contents of most books, both old and new, are not available online either. That is a huge problem. Books are a most important intellectual source because they treat subjects in depth and breadth, often representing the work of years of considered thinking and editing. Much information that is easy to find on the internet is of dubious accuracy, posted by companies or organizations that are trying to sell a product or a point of view. Much of it is also undated, which becomes more and more of a problem as time goes on.

Finally, most local historical documents that are unique to the community that a child lives in are not available online. In a world that is less and less attached to place, this may be some of the most crucial research a student does before leaving school.

Don't children need to learn to do online research?

Online searches are just one way to get to a part of the answer to a research question. The skill of online searching must not be mistaken to stand for all the many ways we can learn about and understand ourselves and the world. For children below middle school, the disadvantages of using the internet generally outweigh its advantages. Sorting through and understanding the information in most web sites requires a high level of reading skills, which are beyond many young children.

Elementary school children should be taught basic library research skills and simple interview techniques and encouraged to interview family members and neighbors for some assignments. By middle school they can be reaching out more widely into the community. Such field research skills can prove invaluable.

Should children be encouraged to use calculators in school?

There are many innovative things to do with calculators, especially with older students. Unfortunately, this is a case of the ideas built into the tool overwhelming the ideas innovative teachers may bring to it. The core idea of the calculator is to calculate, and once the calculators are in the students' possession, it is nearly impossible to stop them from employing them to calculate even the basic arithmetic operations they need to learn to do on their own.

The use of calculators by young children is all too often a choice of substituting a powerful device for inner growth. We believe that the inner growth should come first.

As with the computer, the calculator's operation is opaque—it is impossible to figure out how it is calculating. We should be cautious about employing educational devices that can't reveal how they work to the students. All we do then is substitute one mystery for another. And in mathematics especially, where the key to comprehension is understanding the concepts underlying the facts and procedures, this opacity can cripple the learning process.

Multimedia computer programs often look impressive simply because current textbook- and standardized-test-driven teaching is so sterile and ineffective.

We'd like to reduce our children's exposure to electronic media. How do we do it?

Be sure that electronic media are in places where the entire family can gather and where you can easily and regularly monitor their use—not in children's bedrooms. Set time limits for such use and stick to them. Decide how well the current mix of media products in your home is really serving your family. Some families, for example, keep a television in a closet, to be pulled out occasionally for special shows or to view a videotape now and then. Others are doing something even more radical—forgoing a TV set altogether.

Turning off the TV is something you really can control. And don't just stop letting the children watch. Watch less yourself. Being a couch potato is a learned behavior. Most of us are unwilling to go without television at all, but we can employ it with care. Use the TV as a special activity rather than a time filler, watching programs that you consciously choose to watch, rather than whatever happens to be the best show on. Teach your children to do the same. Establish a TV-free day each weekend (for starters), or make weekdays TV-free, and break the

People can be, and many have been, emotionally scarred by the speed and range at which harmful messages can be broadcast and re-broadcast, entirely out of the control of the original writer's intention.

rules only for special programs. Some families have activities every evening after supper, if homework schedules allow. This can be a time for games, crafts, making cards or gifts for family birthdays, and so on. Once a week family time might include watching a show together.

Some other techniques for cutting back that parents have found helpful include eliminating TV viewing before school in the mornings. Let children play or do something creative before setting off for a day that is increasingly sedentary and test-oriented. Also, if you are trying to wean children away from Saturday morning viewing, consider having a box of special toys or games that get used on Saturday mornings instead of TV viewing.

This approach to using the TV with care can be extended to all electronic media. Computers, stereos, and video games should be used with intention, not as time fillers. But be willing to fill those vacant times with other activities that your children will find valuable—which means that many of them will require your enthusiastic involvement, at least until the children are weaned from electronics. (For further suggestions see the web site of TV Turnoff Network, www.tvturnoff.org.)

What about educational TV, videos, and computer games?

It would be foolish to say that there is nothing a child can learn from educational TV, videos, and computer games, or even that a child will learn less from them than from a textbook. On the other hand, most electronic educational offerings are of low quality and not worth the time or expense.

An occasional special program or series (for example, Ken Burns's Civil War documentary) can be a valuable component of a study of U.S. history. But a steady flow of TV programs, videos, and electronic games poses the problems we've already mentioned to a degree that is likely to be far more significant than any content those media could add. And the content can almost always be learned from other, less developmentally harmful media. Information that flashes across a screen may capture students' immediate attention, but this rapid-fire stimulation may not allow—or demand—much personal reflection or critical thought in the way that books or interactions with other students and teachers often do.

The problems with these educational devices tend to be subtle, gradually developing over time and repeated exposure. And to some extent, their mere presence creates problems. Once you have spent the money on the equipment there is always an urge to use it to justify the expense.

Our observations indicate that once these devices enter the educational environment, their mere presence often alters the way teachers teach and the way parents engage their children—or stop engaging them. Their very power becomes a temptation to the adults themselves, since it requires far less imagination to let a machine entertain and try to teach than to engage and direct children's attention out of our own inner resources. But the most powerful lesson this may actually teach, over time, is that machines are more compelling than anything that happens in real human interactions.

When we tell our kids to turn off the TV and computer they complain that they're bored. What should we tell them?

Education writer John Taylor Gatto relates this story about an encounter with his grandfather:

> One afternoon when I was seven I complained to him of boredom, and he batted me hard on the head. He told me that I was never to use that term in his presence again, that if I was bored it was my fault and no one else's. The obligation to amuse and instruct myself was entirely my own, and people who didn't know that were childish people, to be avoided if possible. Certainly not to be trusted. (Harper's magazine, September 2003, p. 33)

We most certainly do *not* advise people to bat their children hard on the head. But we should take Gatto's grandfather's insight to heart. As long as we take responsibility for entertaining our children (or turn it over to a machine), they are likely to be unable to find sufficient energy or initiative to take on that responsibility for themselves. Responding to their pleas by giving in is really enabling a dependent relationship with these devices, something that we ought to recognize as dangerous to their emotional health.

Boredom, after all, is better than mindless consumption of anything. Often, it is the seed from which more creative pursuits and social skills grow. Let children get bored, talk to each other, even fight with each other, rather than watch TV or divert themselves with other electronic babysitters. They'll learn far more about themselves and each other through fighting and resolving issues rather than sitting next to each other in a passive box. And much of the time they won't be fighting but exploring and creating together.

Technology is just a tool that can be used badly or well, isn't it?

Most of us have some deep-rooted ideas about tools, based on our culture and our own background. One of them is our perspective about whether we make tools to serve human needs or whether we make tools to realize an exciting technical possibility and then look for some need it can help us meet—or create one. Is it the human for the tool or the tool for the human? It's time we consciously focus on our values and our goals in making technological choices.

Technology certainly can be used badly or well, but it is never "just" a tool in the sense that it is solely up to us how to use it. One may use an automobile to run others off the road or to take a sick person to the hospital, but to use it at all requires roads, gasoline, insurance, and often a garage. Every powerful tool makes demands on us, and its use in any way alters the way we live and engage the world. Those changes are rarely all good or all bad. But too often they come about without deliberation, causing important facets of our lives to be diminished as a result of adapting to a new technology. This is why we must teach our children to be mindful and responsible in contemplating their use of technology. And that's also why it's essential to be mindful and responsible in selecting the technologies that are most appropriate for educating our children.

Appendix

Resources for Technology Awareness

The Alliance for Childhood acknowledges Professor Lowell Monke as the major source for this list. For a full annotated list, see the Alliance web site, www.allianceforchildhood.org.

Classics in the critique of technology's social, political, and ecological impact

The Unsettling of America, Wendell Berry, 1977. Sierra Club Books, San Francisco.

Silent Spring, Rachel Carson, 1993 (original, 1962). Houghton Mifflin.

So Human an Animal, Rene Dubos, 1968. Charles Scribner's Sons, New York.

The Technological Society, Jacques Ellul, 1954 (English translation 1964).

The Question Concerning Technology and Other Essays, Martin Heidegger, 1977.

The Selling of Science, Dorothy Nelkin, 1995, revised second edition (original, 1987). W.H. Freeman, New York.

Tools for Conviviality, Ivan Illich, 1973. Harper & Row, New York.

Four Arguments for the Elimination of Television, Jerry Mander, 2002 (original, 1978). HarperCollins, New York.

Understanding Media, Marshall McLuhan, 1964. McGraw-Hill, New York.

The Myth of the Machine, Volume 2: The Pentagon of Power, Lewis Mumford, 1964. HBJ, New York.

Computer Power and Human Reason: From Judgment to Calculation, Joseph Weizenbaum, 1976. W.H. Freeman, New York.

Autonomous Technology, Langdon Winner, 1977. M.I.T. Press, Cambridge.

Modern Times, a film written, directed, and produced by Charlie Chaplin, 1936.

Technology and society

The Spell of the Sensuous, David Abram, 1996. Vintage, New York.

Life is a Miracle—An Essay Against Modern Superstition, Wendell Berry, 2000. Counterpoint, Washington, D.C.

Technology and the Character of Contemporary Life, Albert Borgmann, 1984. University of Chicago Press, Chicago.

Holding on to Reality, Albert Borgmann, 1999. University of Chicago Press, Chicago.

The Technological Bluff, Jacques Ellul, 1990. William B. Eerdmans, Grand Rapids.

Harvesting Minds: How TV Commercials Control Kids, Roy F. Fox, 1996. Praeger, Westport, Conn.

The Tragedy of Technology, Stephen Hill, 1988. Pluto Press, London.

Technology and the Lifeworld, Don Ihde, 1990. University of Indiana Press, Bloomington.

Fatal Harvest: The Tragedy of Industrial Agriculture, Andrew Kimbrell, ed., 2002. Foundation for Deep Ecology, Sausalito, Calif.

Consuming Kids, Susan Linn, 2004. New Press, New York.

In the Absence of the Sacred: The Failure of Technology and the Survival of the Indian Nations, Jerry Mander, 1991. Sierra Club Press, San Francisco.

The Age of Missing Information, Bill McKibben, 1992. Random House, New York.

The Religion of Technology: The Divinity of Man and the Spirit of Invention, David Noble, 1997. Alfred A. Knopf, New York.

Things That Make Us Smart: Defending Human Attributes in the Age of the Machine, Donald Norman, 1993. Addison-Wesley, Reading, Mass.

Earth in Mind—Essays on Education, Environment, and the Human Perspective, David Orr, 1994. Island Press, Washington, D.C.

The Culture of Technology. Arnold Pacey, 1983. M.I.T. Press, Cambridge.

Technopoly: The Surrender of Culture to Technology, Neil Postman, 1992. Vintage Books, New York.

Time Wars: The Primary Conflict in Human History, Jeremy Rifkin, 1989. Simon & Schuster, New York.

The McDonaldization of Society, George Ritzer, 1996. Pine Forge Press, Thousand Oaks, Calif.

The Cult of Information: A Neo-Luddite Treatise on High-Tech, Artificial Intelligence, and the True Art of Thinking, Theodore Roszak, 1994. University of California Press, Berkeley.

Rebels Against the Future: The Luddites and Their War on the Industrial Revolution, Kirkpatrick Sale, 1995. Addison-Wesley, Reading, Mass.

Biopiracy: The Plunder of Nature and Knowledge, Vandana Shiva, 1997. South End Press, Boston.

Democracy and Technology, Richard Sclove, 1995. Guilford Press, New York.

Future Imperfect: The Mixed Blessings of Technology in America, Howard P. Segal, 1994. University of Massachusetts Press, Amherst.

Born to Buy, Juliet Schor, 2004. Scribner, New York.

The Resurgence of the Real: Body, Nature, and Place in a Hypermodern World, Charlene Spretnak, 1999. Routledge, New York.

God and the Chip—Religion and the Culture of Technology, William Stahl, 1999. Wilfrid Laurier University Press, Waterloo, Ontario.

The Future Does Not Compute—Transcending the Machines in Our Midst, Stephen Talbott, 1995. O'Reilly and Associates, Sebastopol, Calif.

Why Things Bite Back—Technology and the Revenge of Unintended Consequences, Edward Tenner, 1997. Alfred A. Knopf, New York.

Controlling Technology—Contemporary Issues, William Thompson, ed., 1991. Prometheus Books, Buffalo.

The Second Self—Computers and the Human Spirit, Sherry Turkle, 1984. Simon & Schuster, New York.

The Whale and the Reactor: A Search for Limits in an Age of High Technology, Langdon Winner, 1986. University of Chicago Press, Chicago.

Society, Ethics, and Technology, Morton Winston & Ralph Edelbach, 2000. Wadsworth, Belmont, Calif.

The culture of cyberspace

The Gutenberg Elegies: The Fate of Reading in an Electronic Age, Sven Birkerts, 1994. Faber and Faber, Boston.

Resisting the Virtual Life, James Brooks and Iain A. Boal, eds., 1995. City Lights Books, San Francisco.

Data Smog—Surviving the Information Glut, David Shenk, 1997. HarperEdge, San Francisco.

War of the Worlds: Cyberspace and the High-Tech Assault on Reality, Mark Slouka, 1995. Basic Books, New York.

Silicon Snake Oil—Second Thoughts on the Information Highway, Clifford Stoll, 1995. Doubleday, New York.

Life on the Screen: Identity in the Age of the Internet, Sherry Turkle, 1995. Simon & Schuster, New York.

Computer safety

Computers and Visual Stress: Staying Healthy, Edward Godnig, 1991. Abacus Software.

Repetitive Strain Injury: A Computer User's Guide, Emil Pascarelli and Deborah Quilter, 1994. John Wiley & Sons.

The Computer User's Survival Guide, Joan Stigliani, 1995. O'Reilly and Associates, Sebastopol, Calif.

Impact of advanced technologies on education

The Child and the Machine: How Computers Put Our Children's Education at Risk, Alison Armstrong and Charles Casement, 2000. Robins Lane Press, Beltsville, Md.

Literacy in the Cyberage: Composing Ourselves Online, R.W. Burniske, 2000. Skylight, Arlington Heights, Ill.

Breaking Down the Digital Walls: Learning to Teach in a Post-Modem World, R.W. Burniske and Lowell Monke, 2001. SUNY Press, Albany, N.Y.

Reclaiming Childhood, William Crain, 2003. Times Books, New York.

Oversold and Underused: Computers in the Classroom, Larry Cuban, 2001. Harvard University Press, Cambridge.

The Cultural Dimensions of Educational Computing: Understanding the Non-neutrality of Technology, C. A. Bowers, 1988. Teachers College Press, New York.

Let Them Eat Data—How Computers Affect Education, Cultural Diversity, and the Prospects of Ecological Sustainability, C. A. Bowers, 2000. University of Georgia Press, Athens.

Education/Technology/Power, Hank Bromley and Michael W. Apple, eds., 1998. SUNY Press, Albany, NY.

The Hurried Child: Growing Up Too Fast Too Soon, David Elkind, 2001, third edition (original, 1981).

Failure to Connect: How Computers Affect Our Children's Minds—And What We Can Do About It, Jane M. Healy, 1998. Simon & Schuster, New York.

In Schools We Trust: Creating Communities of Learning in an Era of Testing and Standardization, Deborah Meier, 2002. Beacon Press, Boston.

Taming the Beast: Choice and Control in the Electronic Jungle, Jason Ohler, 1999. Technos, Bloomington, Ind.

The Flickering Mind: The False Promise of Technology in the Classroom and How Learning Can Be Saved, Todd Oppenheimer, 2003. Random House, New York.

A Is for Ox: Violence, Electronic Media, and the Silencing of the Written Word, Barry Sanders, 1994. Pantheon Books, New York.

The Teacher as Expert, Robert Welker, 1992. SUNY Press, Albany, NY.

The Computer in Education, Douglas Sloan, ed., 1985. Teachers College Press, New York.

Teachers and Machines: The Classroom Use of Technology Since 1920, Larry Cuban, 1986. Teachers College Press, New York.

Education, Information, and Transformation: Essays on Learning and Thinking, Jeffrey Kane, ed., 1999. Prentice Hall, Upper Saddle River, N.J.

Computers in Education, Robert Muffoletto and Nancy Nelson Knupfer, eds., 1993. Hampton Press, New Jersey.

The End of Education, Neil Postman, 1995. Alfred A. Knopf, New York.

The Classroom Arsenal, Douglas Noble, 1991. Falmer Press, New York.

Education and the Cult of Efficiency, Raymond Callahan, 1962. University of Chicago Press, Chicago.

The One Best System—A History of American Urban Education, David Tyack, 1974. Harvard University Press, Cambridge.

Educating for social ethics in action

The Compassionate Classroom: Lessons That Nurture Wisdom and Empathy, Jane Dalton and Lyn Fairchild, 2004. Zephyr Press, imprint of Chicago Review Press, Chicago.

Schools with Spirit: Nurturing the Inner Lives of Children and Teachers, Linda Lantieri, ed., 2002. Beacon Press, Boston.

The Courage to Teach, Parker J. Palmer, 1998. Jossey-Bass, San Francisco.

Technophilia

What Will Be: How the New World of Information Will Change Our Lives, Michael Dertouzos, 1997. HarperEdge, New York.

The Connected Family: Bridging the Digital Generation Gap, Seymour Papert, 1996. Longstreet Press, Atlanta.

Walden Two, B. F. Skinner, 1948. Prentice-Hall, Englewood Cliffs, N.J.

Growing Up Digital: The Rise of the Net Generation, Don Tapscott, 1998. McGraw-Hill, New York.

Fiction

Brave New World, Aldous Huxley, 1932. Harper and Row, New York.

Player Piano, Kurt Vonnegut, Jr., 1999 (original, 1952). Delta.

"The Machine Stops," in *The Eternal Moment and Other Stories*, E. M. Forster, 1928. Harcourt, Brace and World, New York.

Electronic newsletters, news lists, and online resource lists

Confronting Technology: A web site of resources compiled and annotated by Lowell Monke of Wittenberg University, which this resource list is based on. Go to www.gemair.com/~lmonke/ main.html.

NetFuture: An electronic newsletter on technology and human responsibility, edited by Steve Talbott. Subscription address: listserv@maelstrom.stjohn.edu (enter into the body of the message "Subscribe Netfuture first name last name").

Federation of Activists for Science and Technology (FASTnet)—an online discussion group moderated by the Loka Institute. Go to Loka's web site, www.loka.org, for details of subscribing.

LokaAlerts: Periodic newsletter of the Loka Institute, a non-profit that advocates for broader public participation in research and technology policy. Go to Loka's web site, www.loka.org, for details of subscribing.

Magazines that critique the social impact of technologies

Adbusters. A reader-supported magazine that challenges consumer culture, 604-736-9401, www.adbusters.org.

Orion. A publication of the Orion Society, which seeks to "inform, inspire, and engage civil society in becoming a significant cultural force for healing nature and community," 413-528-4422, www.orionsociety.org.

Resurgence. Published in the United Kingdom, the magazine is an international forum for ecological and spiritual thinking, 44-1208-841-824, www.resurgence.org.

YES! A Journal of Positive Futures. Bainbridge Island, Wash.: 800-937-4451, www.yesmagazine.org.

Resources for coloring childhood green

Center for Ecoliteracy, Berkeley, Calif.; 510-845-4595, www.ecoliteracy.org. (Publications by its imprint, Learning in the Real World, include: *Getting Started: A Guide for Creating School Gardens as Outdoor Classrooms*, and *The Edible Schoolyard*.)

Center for Environmental Education of Antioch New England Institute, 603-355-3251, www.schoolsgogreen.org.

Center for Respect of Life and Environment, Washington, D.C.: 202-778-6133, www.crle.org.

The Edible Schoolyard, Berkeley, Calif.: 510-558-1335, www.edibleschoolyard.org.

Green Teacher Magazine, Niagara, N.Y. (Green Teacher also publishes books, including *Greening School Grounds: Creating Habitats for Learning*: 416-960-1244, www.greenteacher.com.

The Jane Goodall Institute, Silver Spring, Md.: 301-565-0086, www.janegoodall.org.

The Nature Institute, 518-672-0116; http://natureinstitute.org.

Science and engineering professional organizations

American Association for the Advancement of Science, www.aaas.org. (See also AAAS Office of Public Policy at www.aaas.org/port_policy.shtml.)

American Physical Society, www.aps.org.

Computer Professionals for Social Responsibility,www.cpsr.org.

Consortium of Social Science Associations (COSSA), www.cossa.org.

National Academy of Engineering, www.nae.edu.

National Academy of Sciences, www.nas.edu.

Federal science and technology agencies

National Science Foundation, www.nsf.gov.

Defense Agency Research Projects Administration (DARPA), the central research and development arm of the Department of Defense, www.darpa.mil.

White House Office of Science and Technology Policy, www.ostp.gov.

National Institutes of Health, the world's largest institution devoted to health research, including mental health research, www.nih.gov.

U.S. Congress:
Committees of U.S. Senate, www.senate.gov.
House of Representatives, www.house.gov.

THOMAS, the Online Legislative Service of the U.S. Library of Congress, http://thomas.loc.gov.

Nonprofit organizations that critique science and technology policies

Co-op America, www.coopamerica.org.

Federation of American Scientists, www.fas.org.

Independent Media Center, http://indymedia.org.

Institute for Agriculture and Trade Policy,www.iatp.org.

Institute for Energy and Environmental Research,www.ieer.org.

International Center for Technology Assessment,www.icta.org.

International Society for Ecology and Culture,www.isec.org.uk.

Loka Institute, www.loka.org.

Orion Grassroots Network,www.oriononline.org/pages/ogn/index.cfm.

Science and Environmental Health Network,www.sehn.org.

The Turning Point Project, www.turnpoint.org.

Union of Concerned Scientists, www.ucsusa.org.

United for a Fair Economy, www.faireconomy.org.

Nonprofit organizations that challenge marketing aimed at children and high-tech childhood

Action Coalition for Media Education, www.acmecoalition.org.

Alliance for Childhood, www.allianceforchildhood.org.

Center for a New American Dream, www.newdream.org.

Commercial Alert, www.commercialalert.org.

Dads and Daughters, www.dadsanddaughters.org.

Kids Can Make a Difference, www.kidscanmakeadifference.org.

The Motherhood Project, www.watchoutforchildren.org.

New Mexico Media Literacy Project, www.nmmlp.org.

Stop Commercial Exploitation of Children, www.commercialexploitation.com.

Teachers Resisting Unhealthy Children's Entertainment, www.truceteachers.org.

TV Turnoff Network, www.tvturnoff.org.

Praise for Tech Tonic
Towards a New Literacy of Technology

"The effects of powerful new technologies on children—like the effects of raising temperature one degree at a time—have typically been imperceptible. *Tech Tonic* looks clearly at the often harmful effects of these ubiquitous media and puts forth a set of sane principles and helpful examples."

***Howard Gardner, Ph.D.**, Hobbs Professor of Cognition and Education, Harvard Graduate School of Education; author of* Changing Minds *and co-author of* Good Work.

"*Tech Tonic* demonstrates clearly, and with abundant evidence, the harm being done to children and youth by their too early and too unregulated exposure to technology. Its call to action is equally clear, direct, and doable. I hope with all my heart that the message of *Tech Tonic* gets heard, not just by parents, but by those creating and merchandising the many harmful products now available to children and youth."

***David Elkind, Ph.D.**, Professor, Department of Child Development, Tufts University, and former president of the National Association for the Education of Young Children.*

"*Tech Tonic* is a stunning analysis of the potential harms to children and society from the runaway technology that we so uncritically embrace. This report's urgent call for debate, dialogue, and research on the long-term effects of new technologies should guide the thinking of everyone concerned about the future of humanity."

***Alvin F. Poussaint, M.D.**, Professor of Psychiatry, Harvard Medical School.*

"Reading this solidly researched book and heeding its message takes courage, but it is vital that we do so. In Mission Hill's kindergartens and primary grades, we shun virtual reality in favor of the amazing and awesome real world. Grounding ourselves in nature—real people included—and the traditional technologies of good talk comes first, along with digging in real soil and observing real butterflies. I hope *Tech Tonic* sparks a rethinking of how we introduce young children to the larger world."

***Deborah W. Meier**, MacArthur Award recipient; Co-Principal, Mission Hill School, Boston, Massachusetts*

"Will our children become masters or victims of their digital 'tools'? This trenchant and practical manifesto urges a re-thinking of our attitudes about youngsters' computer use. Read it and heed it—for the sake of the next generation of human minds."

***Jane M. Healy, Ph.D.**, educational psychologist; author of* Failure to Connect: How Computers Affect Our Children's Minds *and* Your Child's Growing Mind.

"The Alliance for Childhood is the best organizational friend today's children have. Its mission is to leave no child behind in a wasteland of poorly thought out, mind-numbing, and soul-crippling technology."

***David W. Orr, Ph.D.**, professor of environmental studies and politics, Oberlin College; author of* Earth in Mind: Essays on Education, Environment, and the Human Prospect.

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