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INFORMATION TECHNOLOGIES AND THE FUTURE OF SCHOOLING IN THE UNITED STATES

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We argue that the inability of schools to embrace new core technologies lies in the nature of schools as social institutions. Thus the catalytic power of information technologies is likely to leave the core practices of schooling untouched, and instead open up a wide range of alternative learning venues to traditional schools. We see the seeds of a technology-driven, alternative system emerging in the recent movements toward home schooling, virtual schools, distance education, learning centers, workplace learning, and informal learning opportunities. As these venues continue to develop, we believe they will begin to converge as a viable alternative to the existing school systems.

Keywords: Education reform; educational technology.

We have all heard stories about how technology is changing learning:

> *A computer firm in India puts a window into the World Wide Web on a wall in a New Delhi slum. The slum kids start exploring the Web without any previous computer experience or English literacy. They teach each other how to explore the Web. Their favorite site is the Disney Corporation site where they can watch Mickey Mouse and Donald Duck.*[1]
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> *The parents of a young mathematical whiz decide that he is not getting anything out of school. So they decide to teach him at home while letting him take gym classes in school. A retired engineer is*

[1]Personal communication; see also Siliconeer Report (2005).

> *enlisted to introduce him to the wonders of educational software. He introduces the kid to many different software programs, such as Geometer's Sketchpad and Mathematica, where the kid can push his mathematical knowledge to the limits. When he grows up, he participates in the international mathematics Olympiad.*[2]
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> *Seymour Papert, a technology visionary, tells the story of how when his grandson was three years old, he had a passion for dinosaurs. So his parents bought him lots and lots of videos about dinosaurs. He watched them over and over. As Seymour put it, "Before he could read, he learned much, much more about dinosaurs than I will ever know!"*[3]
>
> *A 40 year-old inherits a windfall when her parents die and she wants to know how to invest the money. So she searches the Web and finds a tutorial on investing on the Motley Fool Website. She teaches herself about stocks and bonds and real estate investing, so that she can invest her money wisely.*[4]
>
> *Korean teens flock to Internet cafes in order to play on-line games such as Lineage. They fuel a lucrative virtual economy, practice virtual trades, and engage in clan-based warfare. The South Korean government grows concerned when Lineage clan conflicts spill over into real-life street fighting.*[5]

The common thread running through all of these stories is how new technologies create learning opportunities that challenge traditional schools and colleges. These new learning niches enable people of all ages to pursue learning on their own terms. People around the world are taking their education out of school into homes, libraries, Internet cafes, and workplaces, where they can decide what they want to learn, when they want to learn, and how they want to learn.

Information technologies are reshaping and extending our capacity to communicate. Learning to read and write, calculate and think, key aspects of our communicative capacity, are at the heart of schooling. Yet our schools, relying on proven technologies such as books, blackboards, worksheets, and paper and pencil tests, have been curiously resistant to the influence of information technologies. Unlike modern workers, students in schools do not do much of their work in computer environments. Computers mostly are found in labs for special courses and remain peripheral to core instructional practices. As information technologies accelerate

[2]Personal communication. For information on Geometer's Sketchpad, see http://www.keypress.com/sketchpad/; for Mathematica see http://www.wolfram.com/.
[3]Personal communication.
[4]Personal communication. For information on the Motley Fool, see http://www.fool.com/.
[5]Levander, M. (2001). For more information on the social implications of online gaming, see Castronova, E. (2005) and Constance Steinkuehler's work at http://website.education.wisc.edu/steinkuehler/mmogresearch.html.

change in modern workplaces, the gap between the technologies of work and school grows wider. Trying to prepare students for the 21st century with 19th century technology is like training people to fly rockets by riding bicycles.

We argue that the inability of schools across the world to embrace new core technologies does not stem from the reluctance of students, teachers, and leaders to invest in technologies, but lies instead in the nature of schools as social institutions. We use the evolution of public schooling in the United States as a case study for considering how new technologies are likely to shape the practices of teaching and learning in schools. We contend that, as the structures and cultures of institutions evolve, their core practices become increasingly resistant to change. Thus the catalytic power of information technologies are likely to leave the core practices of our highly evolved institutions of schooling untouched, and will instead converge into components of a parallel, alternative learning system.

1. Technology Enthusiasts and Skeptics

Enthusiasts of technology struggle with skeptics to predict whether the practices of schooling will be transformed by or be resistant to the effects of information technologies. Enthusiasts point to how technologies have already reshaped communication and information exchange practices across professions and disciplines (e.g. diSessa, 1999; Gee, 2003; Papert, 1994).There are three imperatives of information technology that can radically change the nature of education:

- *Customization.* Enthusiasts believe that technology offers a variety of ways to break the lockstep of schooling. It can address the individual interests of the learner. It can adjust to the pace of the learner, providing personalized feedback to address the learner's particular difficulties. In short, it can customize the content, pedagogy, and assessment to the learner's needs, interests, and abilities. There is no way that teachers will ever be able to do this, given that they must attend to twenty or more students at a time.
- *Learner control.* New technologies, like the printing press before them, enable people to take control of their own learning. Outside of school, people can decide what would be valuable to them and what they want to learn. They can decide how long they want to spend and what help they think they need. They are gaining more and more control over their own learning, both in big ways and in small ways. Hence, the imperative of technology is toward more learner control, and schools are fighting a losing battle to control what students learn. Technology enthusiasts think people will decide to take control of their own education, when they see it is possible.
- *Interaction.* Computers are highly interactive, which provides a number of capabilities that can enhance education. By providing dynamic interaction, computers are likely to make education much more engaging. Interaction also allows learners to see the consequences of their actions. For example, complex games give users rich feedback on the consequences of a series of actions or a strategy

for interaction. To succeed in the games, users need to comprehend what this feedback means, and take the lessons of their experience into account in future play. Another capability that this interaction provides is the possibility of online assessment of students. By giving students complex tasks to perform, such as troubleshooting a complex circuit, computers can provide support to the student to carry out the task, while assessing just how much and what kind of support the student needs. Because of the large number of students in classrooms, teachers cannot provide the kind of interaction and feedback that computers can.

While enthusiasts have predicted great revolutions in American schooling as a result of technological innovations, skeptics point out how school systems resist technological innovation. Cuban (1986) notes how radio, TV and filmstrips were projected to transform schooling, and instead were marginalized by existing practice. As Cuban (2001) describes, in many school systems computer technologies are meeting with similar fates. This reluctance to embrace new technologies is rooted in the institutional evolution of public schooling.

2. Technology and the Evolution of Public Schooling in the United States

At the inception of universal schooling in mid-19th century America, schools experienced rapid change and considerable variation in practice as they struggled to replace the apprenticeship system which dominated education prior to that time. In a short time (from about 1850 until 1910), local variation in instructional, curricular and governance practices stabilized into a system, variously described as a "factory model" (Callahan, 1962), "real school" (Metz, 1990), and the "one best system" (Tyack, 1974).

In this model of schooling, the teacher is an expert whose job is to transmit knowledge to students through lecture, recitation, drill, and practice. The curriculum spells out content and sequence of learning. Locally developed assessments determine if students have learned what was covered. As students advance, they acquire a transcript of courses taken and grades assigned. Graduation from school is determined by passing a sufficient number of courses. The technologies that have supported this system are the textbook to determine curricular scope and sequence, the blackboard and overhead projector to support teacher explanations and display of student work, and paper and pencil to record and assess student work. Similar practices have evolved in many post-secondary and graduate education institutions and have proven equally resistant to change. In the course of the development of the school system, all these pieces evolved to fit together into what Cuban (1984) calls a system of "situationally constrained choice."

The commonality of core practices in schools is surprising considering the relative absence of uniform control. Contemporary public schools display remarkably little variation in curricular and governance practices and have developed great capacity to maintain equilibrium among core practices in a wide variety of local

circumstances. Weick (1976, 1982) explains that while a loose coupling of governance and instructional practices makes each system adaptable to local circumstance, it also protects the core practices of instruction from inspection and alternation due to local conditions. This makes widespread change in core practices difficult to achieve. Changing one part of the system pushes other parts to reestablish the original equilibrium in order to protect the integrity of the core practices. For example, if changing the assessment system means that students fail, parents and teachers will pressure the system to revert to the original assessments, instead of pushing for sustainable changes in teaching practices. The nature of piecemeal instructional changes in complex systems means that innovations will often be dismissed, marginalized or co-opted by the existing practices. The fate of information technology to change core practices is writ large: to the degree technology that is flexible, it will be adapted to fit that system; to the degree that it is not flexible, it will be ignored or kept in the periphery of schooling (Cohen, 1988).

While the enthusiasts' and the skeptics' predictions for the possibilities of technology might be contradictory, we think that together they point to the future relation of education and schooling. There are many reasons why schools do not seem able to embrace the possibilities of new technologies. But, as information technologies become an integral aspect of many communication processes, we think that the dominance of schools as venues for education will diminish. Technologies will open up new alternatives to schools for learning.

3. Seeds of a New System

We see the seeds of an alternative system emerging in the recent movements toward home schooling, virtual schools, distance education, learning centers, workplace learning, adult education, computer gaming environments, educational television and videos, technical certifications, and Internet cafes. Although we believe that technology-supported learning will be particularly transformative for adult learning, movements such as home schooling, virtual schools and learning centers will increasingly address the unmet learning needs of children. As these venues continue to develop, we believe they will begin to converge as a viable alternative for the existing school systems.

3.1. *Home schooling*

Home schooling has been burgeoning in America (over ten-fold growth from 1985–95) as individual families seek alternatives to the established school system. Recent developments in home schooling rely on technologies to distribute materials, provide assessments, and create distributed learning communities. As curriculum materials are developed, computers can take over more of the content burden, leaving parents and others to play the role of facilitators. Groups can get together in homes and community centers to provide education to their children, using network-based materials (Hill, 2000; McDowell & Ray, 2000).

3.2. *Learning centers*

Learning centers are emerging to provide customized supplemental services such as tutoring and test preparation, primarily for K-12 students and others interested in entering colleges and professional schools. Often these centers are associated with universities, such as the Open Universities in many countries. Also in many cities community learning centers are available for adult education. As learning centers become more widespread as supplements to existing educational organizations, they may provide alternative sites for students to legitimately obtain specific career-oriented knowledge and credentials.

3.3. *Virtual schools*

Many governments have developed or sponsored K-12 *virtual schools* as alternatives to public schools. Like other alternative schools, virtual schools provide a flexible schooling environment for students in need of a customized educational program. Virtual schools forgo physical location to provide both synchronous and asynchronous curriculum, instructional assistance, and evaluation for a wide variety of students. The Internet provides a medium through which teachers and their students exchange assignments, feedback, questions and concerns. State-sponsored virtual schools are controversial because they can divert needed resources from existing school programs and provide public-funded education options for home schoolers who opt out of the public program. Still, virtual schools represent new possibilities to deliver educational services beyond the reach of traditional public schools systems (Maeroff, 2002; Morris, May 29, 2003).

3.4. *Distance education*

Distance education has become an increasingly viable extension of traditional undergraduate and continuing education programs. Technologies have expanded the range of traditional correspondence courses to provide a variety of synchronous and asynchronous learning opportunities for adult learners. The model of the Open University in the United Kingdom has spreaded across the globe. While independent institutions, such as the University of Phoenix, teach many thousands of students in a wide variety of undergraduate and graduate programs, traditional schools such as Stanford and Harvard Extension offer a variety of courses and programs via distance learning. The online accessibility of prestigious institutions may soon outweigh the skyrocketing costs of going away to college, permanently reforming the market for higher education.

3.5. *Workplace education*

Workplace education has been rapidly expanding over the last 30 years as companies have realized the need to educate their workers to handle complex equipment

and solve novel problems. For example, Cisco Systems has pioneered a technology-based training system that aligns training, instruction and assessment into an integrated learning environment, while at Xerox technicians learn to diagnose machine problems supported by an online system. Technology enables the efficient development and distribution of customized training opportunities for employees. In addition, embedding learning environments in work environments enables employees to access relevant information, as they need it in solving problems. Just-in-time learning systems can take the form of database systems that provide data relevant to problem-solving efforts, or knowledge systems that seek to represent and make accessible the collected wisdom of the organization.

3.6. *Adult education*

Adult education is growing rapidly with more and more adults taking courses in the evening at adult education centers. Some people, who have been out of school for some time, return to get undergraduate or graduate degrees. Many people now go onto the Web to learn about particular topics that they are interested in, such as how to invest in stocks. Book discussion groups are steadily increasing in number. Older people often go on vacations with an educational purpose, such as a retreat to discuss books or a trip with an expert providing guidance. While much of the learning that goes on is recreational, it still provides valuable knowledge that sometimes may lead to a second career or the deep pursuit of a long-term interest which was put aside for work at an earlier age. Perhaps it will turn out that some of our most productive citizens are the older people who use their retirement leisure time to keep learning.

3.7. *Video games*

Video games typify the generational split in technological learning environments. In schools, teachers condemn games as a waste of time at best and as a corrupting influence at worst. Meanwhile, the very students that schools have most difficulty engaging can spend hundreds of hours immersed in a complex video game requiring considerable literacy, social, and problem-solving skills for successful play. The explosive growth of video gaming has demonstrated how digital technologies can create powerful new learning environments. James Paul Gee (2003) explains that video games are so compelling because they are built on powerful learning principles that scaffold learning complex skills. They draw players into roles that may conflict with everyday values and encourage players to notice the gap with their own beliefs. In games such as *Command and Conquer* or *Starcraft*, players take the roles of different sides in a complex war between civilizations. To succeed in the game, players must understand the resources and capabilities of each side in the conflict and then switch sides to take on the perspective of the enemy. Such role switching gives players the rare opportunity to see a conflict from multiple perspectives. Some games allow players to build characters and resources in sophisticated simulated worlds with market economies and self-policing communities. Video games

represent the cutting edge for the design of technology-based learning environments and the frontier for how learning will be structured in the future.

3.8. *Educational television and videos*

Many bewail the effects of television on learning, particularly teachers who feel that television is largely responsible for students' unwillingness to sit still and listen to them. Television is certainly a passive medium, compared to reading or interacting with computers and people. But there has been a proliferation of educational shows on television, especially over the last 30 years. At the same time a large number of videos for kids have been produced that emphasize learning, which many toddlers watch over and over. For kids with a special passion, such as horses or dinosaurs, there are many videos their parents can buy them, and they can become specialists on these topics before they can even read. Videos and television for young children provide an access to education that is an entirely new phenomenon. So many programs and videos have been produced in the last thirty years that many kids are now getting a head start in their school education.

3.9. *Technical certifications*

Until recently, schools and colleges had a monopoly on the certification business. By granting high school diplomas and college degrees, their role was to guarantee that their students had attained a certain level of expertise. This gave them a hold on students: either stick it out through school and get your degree or you will be handicapped in trying to get a job. In recent years, a host of companies, such as Microsoft, Cisco and Novell, as well as technical societies, have started to muscle in on the certification process by offering exams that certify the mastery of technical skill in computer-related occupations. These certification programs over the long run are a real threat to the monopoly of schools and colleges. Because the certifications are more specific, they are in fact more meaningful to potential employers. They specify exactly what skills a student has acquired in a way that a high school diploma or a college degree cannot do. Furthermore, because the certifications are so specific, it is possible to tailor any educational program directed toward them much more carefully. In fact, the companies and technical societies that are developing the certifications have in many cases developed very clear specifications as to what and how courses should be taught to prepare people to take the certification exams.

3.10. *Internet cafes*

All over the world Internet cafes are springing up, where people can go and log on to the Web for a small fee. These cafes are the libraries of the future. They particularly attract young people who spend hours on the Web, engaging in conversations and games, reading about what is happening in the world, learning how to program, or exploring different sites that relate to their interests. More and more of the world's

accumulated knowledge is spreading to the Web. Hence, with access to the Web in many locations, people will be able to educate themselves. This is the role that libraries have played in the past. As people all over the world see the necessity of an education to prosper in a technological society, they are likely to start teaching themselves through the resources of the Web.

3.11. *Implications*

The seeds of this emergent system may not be an improvement on current public schooling systems in the United States. Customization and adaptation come at a significant cost. The goals of a public schooling system to create a common sense of civic responsibility will be further fragmented as people with means opt for individualized programs of study. Information technologies can also lead to the fragmentation of knowledge. While standard curricula in schools aimed to establish a common knowledge base for all citizens, technologies afford learner-directed curricula, which may focus on what students choose to learn instead of what institutions claim they need to learn. Large companies are entering the market to make information widely available, thus potentially increasing the commodification of knowledge and the corporatization of the learning process. Each of these pieces point out how a new system driven by the demands of local circumstance can come at the cost of social cohesion.

How does this analysis of technology and American schools help inform studies of Asia-Pacific schools? Many Asian nations have rebuilt their education systems in the past fifty years to emphasize tightly coupled linkages between curriculum, teaching and testing. Countries such as Taiwan, Singapore, South Korea and Japan use centralized, national control to improve educational quality by reducing the variation in instructional practices (Chon, 1995; Stigler & Hiebert, 1999). National policy makers in these countries have recently pressed for significant investments in low-priced learning technologies that may help their education systems "leapfrog" some of the developmental steps taken by developed economies (Osin, 1998; Singh, 1999). Technology investments in these tightly-coupled national education systems are likely to play out differently than in the United States. Centralized control over the curriculum and teaching practice means it may well be more likely that the kinds of technology changes emerging throughout the US could be mandated in Asian schools. However, there may be a more subtle force at work here. As we have argued, the American tradition of local variation sanctions the emergence of alternative educational practices that initially challenges, then comes to form a parallel track to the overall education system. The nationally controlled education systems of South Korea and Singapore, for example, seem less likely to sanction the emergence of grass-roots innovations that arise outside the education system. Recent research by Arphattananon (2005), for example, describes the difficulty of Thai governmental reforms to shift budgeting and personnel decisions from the national to regional control, while Woon-ha (2005) describes the struggle of South

Korean teachers to influence their incentive and salary schedules. These accounts demonstrate the difficulty of allowing local variation to influence national policy directives. The strength of the American educational system is the ability to adapt to the pervasive demographic and economic shifts of American life. As Asian economic development continues to reach new levels, experiments with American-style, decentralizing reforms may result in the kinds of emergent practices that are contributing to the second educational revolution in the US.

4. Conclusion

We are neither advocates nor opponents of computers in schools. Rather we are observers of what is happening and take a historical perspective on the relation of schooling, learning, and technology. What will happen with the relation of computers and education is not in any sense inevitable. In fact it is at critical times of change that the actions of particular individuals and groups have the most impact. The advent of the industrial age opened a window for visionaries such as Horace Mann and his contemporaries to shape the education system of today. We again find ourselves at such a window of opportunity, where there is a battle raging between conventional and revolutionary venues for learning. There are many educational visionaries alive today. The dreams of most of them are likely to fail, but a few may capture the moment with the right idea and the right approach to implementing their idea. What we are trying to do is to describe the context in which they are working, in order to give some idea of what that context makes possible to accomplish.

The changes we see happening in education are neither all good nor all bad. We see many benefits to the kinds of education that technology affords, such as the ability of learners to pursue deeply topics of interest to them and to take responsibility for their own education. We also see many benefits in the successful history of traditional public schooling which has provided extraordinary access to learning, status, and economic success for millions of students over the course of the past two centuries. But, at the same time, the roads to dystopia are also open. In particular, the new technologies can undermine both the vision of educating citizens who can make sensible public policy decisions and the vision of a society where everyone can succeed by obtaining a good education. Increasing the ability to personalize educational opportunities gives a natural advantage to those who can afford the services. Our fear is that citizenship and equity may be undermined by the technological revolution. We hope that by revealing the larger pattern of what is happening, we will make it possible for society to ward off the dangers and exploit the possibilities.

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