Critical Perspectives on the Evolution of Technology in American Public Schools

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This nation has historically viewed technology as a powerful, independent force for social change and superior education. Despite the enormous value placed on technology, however, the vision of dramatically superior education pouring great young minds into society has not materialized. In fact, the overall impact of technology on education has been quite small, manifesting little discernable change in the classroom. With the enormous promise that so many believed technology offered for education, why has that promise failed to materialize?

This paper will trace the evolution of technology attempted in the public schools, and the great expectations and subsequent failure to meet the majority of them. Generally speaking, these failures have resulted not from a refusal on the part of teachers to apply the technologies, but the social-situational influences that are an integral part of the public educational milieu. Ultimately, the technologies adopted have been those most easily adapted to existing pedagogical approached, a reality that will remain in the public schools without a dramatic change both in educational paradigm and in method of adoption.

Notre nation a historiquement perçu la technologie comme une force puissante et indépendante de changement social et d'éducation supérieure. Malgré les espoirs énormes placés sur la technologie, la vision d'une éducation radicalement supérieure déversant dans la société de jeunes esprits brillants ne s'est pas matérialisée. En fait, l'impact général de la technologie sur l'éducation a été fort limité, se traduisant par un faible changement discernable dans la salle de classe. Avec l'énorme promesse que la technologie semblait offrir à l'éducation, comment se fait-il que celle-ci ne se soit pas matérialisée ?

Cet article retracera l'évolution de la place de la technologie dans les écoles publiques, les grands espoirs et les échecs subséquents à atteindre la majorité de ceux-ci. De manière générale, ces échecs ne sont pas à attribuer à un refus des professeurs d'appliquer ces technologies, mais aux influences socio-situationnelles qui sont partie intégrante du milieu éducatif public. En dernière analyse, les technologies adoptées furent celles les plus adaptées aux approches pédagogiques existantes, une

réalité qui perdurera dans les écoles publiques sans un changement radical à la fois du paradigme éducatif et dans la méthode d'adoption.

> Americans persistently dream about the liberating effects of technical innovations. There is a St. Simonian, almost utopian quality about these hopes, a sense that technology itself can break the chains that bind us to a dreary, work-a-day routine .... Much of the promotion for microcomputers, among other educational innovations, attends little to their potential for school instruction, focusing instead quite selectively on their more extraordinary possibilities. (Cohen, 1988, p. 240)

Introduction

The United States has historically ascribed enormous importance to the use of technology, maintaining the conviction that technology holds the solutions to society's problems, and viewing technology as a powerful, independent force for social change. The realm of public education has been no exception. Since World War II, the technologies pushed on schools, from paperback books to microcomputers, have been touted as change agents that would reduce student dependency on teachers and offer an economical, mass approach to teaching. *A Nation At Risk* (National Commission on Excellence in Education, 1983) the path-breaking, influential and oft-cited study undertaken during the Reagan administration by Secretary of Education Terrel Bell, described five major themes its authors believed were essential for consideration by policy makers, and all but one of them related directly to technology.[1] Numerous other reports[2] suggested that manufacturing, trade viability, research and development, and standard of living were all threatened because the nation was heading toward becoming a technological dinosaur, and that economic competitiveness and educational productivity are directly linked, with technology as the key to educational productivity and effective education reform.

Despite the mad rush headlong into the technological age and the enormous value placed on technology by the policy makers, however, the vision of dramatically superior education, and the attendant explosion of great young minds pouring into society, has yet to become a reality. In fact, many theorists point out the overall impact of technology on education has been quite small, manifesting little discernible change in the classroom (Nickerson & Zodhiates, 1988; Anandam, 1986; Waks, 1991). With the enormous promise that so many believed technology offered for education, why has that promise failed to materialize?

This paper will trace the evolution of technology attempted in the public schools, note the great expectations attached to the technology, and the subsequent failure to meet the majority of them. It will show that, generally speaking, these failures have resulted not from a refusal on the part of teachers to apply the technologies, but the social-situational influences that are an integral part of the public educational milieu. Ultimately, the paper will conclude that the technologies adopted have been those most easily adapted to existing pedagogical approaches, approaches that developed to serve certain purposes. This reality will remain unless and until the public schools undergo a massive restructuring in educational paradigms, in the ways those paradigms are actualized and supported with technology, and the ways the technology is adopted and applied in the schools.

The term *technology* will be defined in this paper as including both the technological facilities and the institutional arrangements, as well as what Gandy (1992) calls the realm of ideals and values that play a powerful role in determining uses for a technological resource. According to Gandy (1992), there are three critical spheres or components of a technological infrastructure in which uncertain and evolving relations coexist: a) technical, b) economic, and c) cultural. The technical includes hardware, software, the state of distribution of technical knowledge governing the efficient use of that hardware and software, and the organizational forms and managerial practices making technical efficiencies possible. The economic sphere includes the market, its structure, and the conduct of the key players. Gandy notes that there is an increasing problem of specifying the boundaries of the relevant market, and of identifying the key players. Under the cultural rubric, Gandy includes the values and expectations governing acquisition and use of technological resources within and outside of formal markets. These values should be studied not just through the regulatory environment, but also through the normative thinking of those people in daily practice, and through public opinion. Broadly speaking, then, the educational technology explored here will refer to the materials, the content, the approaches or techniques in applying it, and the social milieu in which the it is applied.

Enter Technology

Since before the time of Plato, the basis of pedagogy has consisted of a teacher talking to students, accompanied by demonstration if the act involved teaching a skill. Even after the shift during Plato's Greece from oral culture to written technology and the attendant effects written language had in the subsequent classification of knowledge, the classical pedagogical approach has varied little (Havelock, 1963).

This is not to say that technologies have been ignored or discarded without consideration. During the past century and a half, photographs, paperback books, motion pictures, filmstrips, radio, television, and computers each have been hailed in turn as technologies poised to revolutionize education. The net result, however, has been anything but revolutionary. Attempts to move innovation and technology into the public schools has achieved some success, but rarely in the ways the planners had anticipated, and rarely when applied to the mainstream student population.

In an early technological breakthrough of the 1820s, new printing techniques allowed for greater production and distribution of books, greatly increasing the diversity of materials available to teachers and students (Cohen, 1988). During the next decade, slate boards replaced hornbooks in the classroom, and textbooks became more commonplace in the public schools (Voegel, 1986). As the 19th century drew to an end, the technologies of the day – chalk, slates and chalkboards, books, and pictures – were bolstering knowledge transmission, but the oral exchange among teachers and students remained the core element of academic instruction (Cuban, 1986).

As America adjusted to the industrial revolution of the 19th century, a Taylorist, rationalist philosophy pervaded many institutions; the influence of the efficiency engineers reached into the classrooms and administrative offices of American public schools as well. The sweeping movement of scientific management led to the search for and attempted application of machines and devices, all meant to increase academic production for greater efficiency (Marshall & Tucker, 1992). Typically, as will be discussed, those technologies failed to achieve what the pundits forecast.

As American society entered the 20th century, technology supporters hailed the motion picture as one such efficiency device. Seen as a tool superior to anything yet experienced in the classroom, the moving picture was considered to be the future of education. By 1913, the expectations of this realistic, life-filled medium were so high, in fact, that Thomas Edison predicted that films would replace books and teachers:

> Books will soon be obsolete in the schools. Scholars will soon be instructed through the eye. It is possible to touch every branch of human knowledge with the motion picture. Our school system will be completely changed in ten years. (Voegel, 1986, p. 74)

Film became a symbol of progressive education during this period. Despite the enthusiasm, however, there were numerous logistical problems in its use: lack of content-appropriate films, high cost of films and projectors, lack of teacher training on use, poor pedagogical or curricular fit, and little or no organizational approach behind use of the films (Cuban, 1986). During the half century or so that film appeared in schools, despite its acceptance as a

tool, the use of film was relatively limited, falling far short of the widespread use predicted during the 1910s. While evidence is fragmentary at best, some data are available that indicate the paucity of film use. For example, a study conducted in 1954 stated that in Georgia approximately one film per month per teacher was used, and 32% of the teachers reported they never used film (Dale, 1954). A year earlier, a New Haven, Connecticut study examining the effectiveness of film use in teaching reading showed that, while 175 teachers in grades three, five, and seven ordered 1500 films and filmstrips that year, two-thirds of the orders came from just 14% of the teachers (May & Lumsdaine, 1958).

The 1920s and 1930s brought the same impassioned support for the technology of radio. Benjamin Darrow, founder of the Ohio School of the Air, wrote:

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

A decade later, William Levenson predicted the radio would become an educational medium as common as the blackboard.

From the 1920s to the start of World War II, radio was touted as the revolution in education, but problems stalled widespread use. Radio did achieve some success in the realm of distance learning, especially in rural areas of the country, and programmers and networks provided and broadcast a range of educational material, but radio never fulfilled the expectations vocalized by its proponents. As in film use, data on the use of radio is fragmentary; also, the providers of radio educational programming depended on listenership for commercial success, so many of the available studies were designed to indicate a larger listenership than might have actually existed. During the 1930s and 1940s, estimates were calculated using the number of hours of programming or the number of students in schools with access to radio receivers, but both measures failed to provide accurate evidence of either the number of children actually using radio or radio's utility in education. However, in a 1937 survey of superintendents across the country, seven percent responded that all of their schools use radio (again, the frequency or level of use was not specified), about 17% said many of their schools use radio, 51% stated radio use occurred in few of their schools, and 22% responded that none of their schools used radio (Atkinson, 1938). A 1941 survey of Ohio principals cited numerous reasons for not using radio programming in their schools: broadcast schedules conflicted with class schedules, teachers lacked information on broadcast schedules, programming

was unrelated to curriculum, signal reception was poor, radios were expensive to purchase and maintain, teachers believed classwork was more productive, and problems arose concerning broadcast frequencies and policies for use (Woelfel & Tyler, 1945). In fact, half of the principals reported no equipment at all, and one in five said the equipment available was unsatisfactory. Even when the cost of radios dropped after 1945, use did not increase dramatically By the 1950s, the protechnology pundits were already looking ahead to the next technologies.

Following World War II, a stream of innovations flowed from the developers toward the classrooms, with educators, reformers, and school critics seizing on one after another. Among those innovations were paperback books, thought to be the tools to move students beyond the routine of text, lecture, and recitation.

Considered the oldest new technology in education, books are portable, very flexible, easily produced through modern publishing technology, and they offer variety in how a single subject can be approached. A book is a self-paced tool, enabling the reader to move easily to various places in the book. The book can be used for review and reference, it can be used individually or in groups, and it can be reused. The great advantage to the paperback was its inexpensive price, allowing the teacher to select a large variety of reading materials to create a richer curriculum, and one that could be tailored to each student by matching the author's writing style and content to the student's learning style and ability.

But even with the proliferation and availability of paperbacks, schools have continued to rely on hardback textbooks for nearly all their instructional material and curriculum guidance: textbooks represented a time-tested, effective, self-contained instructional package. Fully utilizing the paperback approach would be enormously time consuming, forcing the teacher to neglect some aspects viewed as important. Another point: despite the fact that books were adopted to move education away from the rigid lecture-and-recitation, whole-class model of teaching and toward a more individualized approach, books were simply adapted to the pre-existing classroom techniques (Cohen, 1988). This phenomenon would recur in later years.

Just as exaggerated claims exalted the value of film, radio, and paperbacks, television was hailed as the device that would forever alter classrooms. Even in the infancy of the medium, theorist E.B. Kurtz (1933) believed so intensely in the power of television as a teacher that he stated: "This new instrumentality bids fair to become the most potent agency of universal education ever conceived. For, in due time, every home will have its own classroom, with professor, blackboard, diagrams, pictures, and students"(sec. 9, p. 4). Television was emerging as an instructional

technology at the same time that voices critical of public education during the middle 1950s were growing louder. Even before the launch of Sputnik, and the subsequent American reaction pushing for dramatically improved science and mathematics programs, criticism was growing toward the quality of the schools and the overcrowding that the first baby boomers were facing. Various accounts are given on where and when the first educational television broadcasts occurred, but the belief in television as an educational tool was demonstrated during the 1950s by large grants from the private sector and the federal government. The Ford Foundation, through its Fund for the Advancement of Education, had invested more than $20 million in 250 school systems and 50 colleges and universities (Saettler, 1968). The National Defense Education Act of 1958 provided matching funds to the states for purchase of instructional technologies (Gandy, 1982), and in 1962, President John Kennedy successfully prompted Congress to authorize expenditure of $32 million for development of television in education. By 1971, in an environment of lobby groups, journal articles, and policy makers, all extolling the virtues of classroom TV, approximately $100 million had been spent by the private and public sectors on development of educational television (American Education, 1971).

Again, however, despite the great claims and occasional successes of television in the classroom, TV has been used relatively little in the course of instruction. Often the programs available fail to match the pedagogical, curricular, or scheduling needs of the classroom. Repeatedly, technology supporters focused primarily on the technology rather than on the instructional organization best suited for its use. Teachers have offered various arguments and reasons for their disinclination to use television in the classrooms, many of which center around the nature of the innovation. The disincentives for teachers include a lack of equipment, rapid obsolescence of equipment, inadequate maintenance of equipment, poor quality signals, mediocre or amateurish programs, programs that ran at inconvenient times (this was prior to wide access to videotape), and programs that ran longer than the 50 minutes typically allotted for a class. Even for those actively engaged in using television in the classroom, the logistics of learning what programming was available and when, learning program details with enough time to plan a class around the programming, and scheduling the television equipment often proved too much to overcome. Program quality – whether it fit the class, was interesting and understandable – often presented its own set of disincentives. As might be expected, television never gained a linchpin position in the educational system.

Cuban (1986) writes that, in the research he reviewed, the issues varied by decade and place, but "both the ubiquity and frequency of the responses

[of teachers to technology used in education] compellingly point to technological deficiencies and the inflexibility of film, radio and television as explanations for infrequent teacher use" (p. 54). Teachers demand a flexible, simple, and accessible tool. Once the novelty wears off, problems inherent in technology use will obliterate any value the teachers may see in it, resulting inevitably in little more than token use.

As the most recent example of widespread technology, the computer, came into more common use in business and industry, it expanded even further the perceived role of technology both in American society and in American education. As with other technologies, supporters heralded the advantages. *A Time for Results* (National Governors Association, 1986) lists a range of tasks that computer technology should be able to perform or assist in:

> Effective instruction for higher order skills through simulation; coaching and tutoring of students through artificial intelligence capabilities; access to, and ability to manipulate, information through computerized databases; enhanced repetitive drill and practice, including corrective feedback; educational opportunities for handicapped students; better record keeping and reporting of information at classroom, school, district, and state levels; and productivity by allowing schools to experiment with a variety of new staffing strategies. (p. 123)

The typical set of attributes goes as follows: The computer is capable of presenting information in ways not previously available, and it was recognized that the representational media and modes of presentation that computers provide could be extremely effective teaching aids. Computer devices continue to grow in speed and power, microprocessors have become pervasive in the electronic and mechanical accouterments of contemporary life, software is more extensive, graphics and process simulation are more intricate, interfaces are more transparent, more computer-based information services exist, and computers present more powerful tools for database searches and access. Time and space can be altered to demonstrate various kind of phenomenon, such as a science experiment or a meteorological occurrence. Computers are interactive, and will respond the student's work with unlimited patience, which is especially useful in drill and problem-practice situations. In addition, a computer can present material in the form of game-like tasks, which can increase motivation (Nickerson & Zodhiates, 1988).

With the advent of computers, many schools engaged in an almost frenetic expansion of all forms of technology, using whatever benefactors the schools could muster (Waks, 1991). This buying frenzy was bolstered by certain federal and state programs that required the purchase of technology

by schools, and by predictions of the revolutionizing of education that appeared in one publication after another throughout the 1980s. Supporters claimed the computer represents the perfect tool for carrying out the basic principles in instructional method: instruction should be individualized, adaptive and interactive, and a computer can carry out all three, leaving the instructor free to attend to special needs of the individual students (Nickerson & Zodhiates, 1988).

The protechnology theorists believed that computers, like film, radio, and instructional television, would force a change in how teachers taught, students learned, and schools organized. The emphasis lay in the relentless striving for greater classroom productivity (Cuban, 1986). Policy makers and administrators, as well as the public, bought wholesale the idea that computers, televisual equipment, and other advanced technologies would effect massive changes in the system of American education, resulting in a dramatically better prepared graduate.

And indeed, many technologies *have* found their way into the classroom and been put to use, often replacing other, less effective technologies. The old lantern slides were replaced by 35 millimeter transparencies. Videocassettes took the place of motion film. Overhead transparency projectors, which had been developed by the military during World War II, became practicable for classrooms when 3M company made both the projectors and transparency material affordable during the 1960s (overhead projectors are still used commonly in schools). Phonographs led to reel-to-reel audio tape, which led to audio cassettes (Voegel, 1986). Nevertheless, these technologies failed to dramatically improve educational productivity. The utopian visions of the past, claiming technology would revolutionize education and completely change the way teachers teach and students learn, have proven to be little more than fantasy.

Many technologies simply did not work and were discarded, such as the computer-aided instruction (CAI) attempted prior to microcomputers, or the multi-booth headset-and-microphone dial-up language labs of the 1970s. The history of such technology follows a predictable pattern: high hopes for marked improvement in education, followed by heavy investment in the technology, followed by uneven deployment in classrooms, and ultimately limited use by teachers. In most of the cases, the technologies that worked effectively acted as *extensions* of the teacher, with control over the class exercised by whomever held the chalk, flipped the light switch, or wrote with the felt-tipped pen on the overhead transparencies. Those technologies that restricted the teacher's control – which were also commonly the most costly, inconvenient, and lacking in adequate materials -- slowed or sidetracked the process of education. In summary, technological devices appear to have had

a minimal impact on the teaching-learning process – little has changed in the classroom (Cohen, 1986; Anandam, 1986; Perelman, 1987; Voegel, 1986).

But research does exist to show that the technologies, in and of themselves, *should* be effective in certain situations. For example, researcher Stanley Pogrow (1986) concluded, as many others have, that distance learning is both a highly effective and highly cost-effective use of technology; educational technology specialist George Hall (1986) testified as to the successful use of interactive videodisc in training and education; and researcher Delores Hagan (1984) discussed how computers and robotics can provide educational and communication opportunities for disabled children. Communication scholar Wilbur Schramm (1977) stated that the debate over the effectiveness of communication technology in educational applications has occurred since the time of moveable type, that technology has been shown effective, and the question of whether the media can teach students is useless and irrelevant. In reviewing research on the effectiveness of various media, Schramm concluded that it is the situation in which those technologies are used that determines whether the technology will succeed or fail. If the content of the medium is relevant, if the medium is appropriate to the content and process required to achieve the educational goals, and if the medium is cost-effective – meaning the same amount of learning can occur with less financial expenditure, or more learning can occur with the same financial expenditure – then the medium should be considered appropriate and used accordingly.

Why, then, has there been such a relative failure of technology use in the classroom? Wagner (1982) explicitly asserts what many implicitly express: that teachers believe their roles, their power, and their very employment are threatened by the technologies, and therefore refuse to allow technology to succeed in the classroom. This "blame the teacher" litany has been taken up by many analysts. Schramm (1977) is a bit more diplomatic, saying that educational institutions are slow to change, and that teachers are suspicious of changes and technologies over which they have not been consulted. He acknowledges a plethora of logistical problems, and notes that overzealous, inappropriate applications have doomed many technologies, concluding that the content is the chief consideration, not the delivery system. However, Schramm essentially states that technology will be effective if the classroom teacher wants it there and has learned how to properly use it.

The critics have tended to blame the teachers for the failures of technology, to see the educators as intransigent Luddites, clinging to the methods of the past because they are incompetent to assimilate the techniques of the future and are threatened by machines that can only improve the quality and efficiency of education. Many believed that the teachers were sabotaging

the process by simply refusing to use the technology properly, if at all. Several reports of the 1980s, such as the National Science Board's *Educating Americans for the 21st Century* (1983), sounded the refrain that teachers must be convinced that computers are not a replacement for them, so as to ensure greater adoption and use. The implicit message was that teachers are the gatekeepers responsible for the success or failure of instructional technology, and must be coaxed into accepting their new role.

But was this failure of technology to radically change the nature of education really the fault of intransigent teachers who felt threatened by change? This is unlikely. In the following section, the constructed teacher is investigated, and his or her role within the larger system of K-12 education is noted. The individual blame approach that positions teachers as saboteurs of neutral, helpful technologies gives way to an explanation that brings attention to the heavy weight of growing institutions and bureaucracies and their sources of inertia and ineffectiveness in implementing change.

Scapegoating the Teachers

While it may be true that, taken as a group, teachers might have a tendency to lean toward conservatism regarding changes in the classroom, especially those changes involving new and unfamiliar technology, one must delve deeper into the background and environment of teachers and public education to understand the reasons. This supposed communal inertia is likely due to the nature and culture of the teaching profession overall, the process through which teachers become teachers, and the larger system in which teaching is but one of many roles.

One's initial exposure to the craft of teaching occurs with the observations inherent in spending many years as a student. Once actually teaching, the individual comes into the field with a fairly comprehensive understanding of the various disincentives inherent in the contemporary educational structure, such as the modest salaries and rigorous work schedules, balanced against incentives that include the chance to have personal contact with students and make a difference in their lives. As a result, teachers are self-selectedly disposed toward the accepted role of schools, leading inevitably more toward stability than change.

The practice of teaching holds several conventions. Teaching requires a high degree of order in the classroom; routines are complicated, and teachers often take refuge in familiar practices rather than ones involving change. Teachers learn from colleagues how to survive in the school, which typically reinforces the status quo and weakens the case for change and technological innovation.

As critical as any points already mentioned is the basic philosophy most teachers hold toward their craft. While policy makers and administrators typically prefer to push instructional methods with specific objectives, extraction of measurable behaviors, and use of standardized testing, these scientific management and rational teaching methods do not reflect the approach deemed appropriate by most educators. Instead, teachers tend to be more concerned with broad, holistic outcomes.

The technological reformers suspect that teachers privilege development of emotional bonds with their students and see technology as a threat to that relationship, so the reformers criticize teachers as Luddites and reactionaries resistant to progress. Charles Hoban (1971), for example, characterized the reaction of teachers to any alteration of the teaching ritual as "resisted as an invasion of the sanctuary by the barbarians" (p. 133). Technology theorist Javad Maftoon flatly asserted, "it has been found that teachers reject or at least resist change because of failure to recognize the need for improvement, fear of experimentation, unwillingness to give time, and disillusion or frustration with past experiences" (Maftoon, 1982). Since people tend to point toward individual motives rather than social settings as the cause of behavior, the teachers emerge as the culprits in the failures of classroom technologies. Teachers are human beings capable of exercising free will and making choices, the reasoning continues, so critics target the teacher candidate pool and their training, experience, and conservative beliefs for their reluctance, characterizing their behavior as resistance to or hostility toward instructional improvement.

However, the critics' arguments fail to explain why some teachers make ample use of technology, while others use technology rarely, if at all. Additionally, many fail to understand that technology is not a replacement for teaching, but a tool to enhance the teaching process. Continuity certainly characterizes the teaching process more than change, and change that did occur occurred, for the most part, in the elementary schools (Cuban, 1984).

Elementary schools are arranged very differently from secondary schools in physical space, time and scheduling of classes, number of teachers for each student, size and type of student groupings, ways in which the teaching takes place, and external performance pressures from various standardized tests. Elementary teachers have worked in a much different context, and have had more flexibility to alter practices away from standard whole group instruction, adapting to shifting needs. Teachers determined the curriculum, the manner of instruction, and the materials used. Consequently, it should not be surprising that elementary schools have typically made better use of technology and other innovations. Moreover, several other school and system constraints – ranging from high teacher-student ratios to low budgets –

clearly influence opportunities to incorporate innovations in the classroom. But the whole-group approach remained the norm in secondary schools, including the standard lecture-recitation pedagogical model as well as textbook assignments, seatwork, and arrangement of the classroom.

Cuban (1986) explains this constancy with what he calls situationally constrained choice, affecting the school and classroom structures as well as the culture of teaching, which would include both the teachers' social and individual beliefs. The structures establish the boundaries in which "individual teacher beliefs and an occupational ethos have worked their influence in shaping daily pedagogy" (p. 64). The school context, in other words, shapes what the teachers do.

Despite the apparent institutional determinism against innovation, however, teachers have changed certain teaching practices and kept those innovations that worked, innovations that eventually became conventions. The problem is not so much a matter of stubbornness on the part of teachers, as technology supporters claim, but of *whose* questions are important, and how the institutional constraints allow those questions, and the accompanying pedagogical techniques to address those questions, to manifest in the classroom.

Innovation: Who Makes the Decisions?

When a school embraces technology, journal and popular press articles typically heap praise upon the endeavor. But the obvious failures of technology to render the anticipated revolutionary changes in the schools result inevitably in the critics blaming teachers and principals as being indifferent or hostile. The more magnanimous of the critics might assert that the educational bureaucracy could have contributed to the problems. But the overwhelming majority of all technology and other innovations brought into the schools has been conceived, developed, and mandated in a process that has traditionally included everyone but those who are most important to the classroom: the teachers. Typically, nonteachers have defined the problems, and nonteachers have dictated the solutions.

Policy makers and nonteaching reformers typically maintain the assumptions that a) a school district and all levels of personnel therein can carry out a mandate under specified conditions in a military way, and b) the teacher is a technician who can carry out a learning function considered to be mechanical in nature, the philosophy being that teaching is something a teacher simply *does* to a student (Cuban, 1986). These assumptions imply that the effectiveness and frequency of technology use depend on how the

technology was adopted and is executed. The primary challenge would be to develop a strategy to coerce teachers into using the technology.

Mandating change in a top-down direction can, in fact, carry certain advantages. Those supporting the change avoid the time and energy that building a consensus to implement the decision would require. Teachers are thus ignored during the planning stages and brought in only during implementation, if then. In addition, the act of adoption does not predict the degree or even existence of eventual use. Often, mandates are handed down that educators distrust, or that conflict with what the school believes is an efficiently running or effective system, or that conflict with the basic goals of the school. The almost-certain result is token adoption, in which the schools take the equipment sent to it and simply make it available to those teachers interested in using it. This way, the school avoids the charge of resisting change, but continues to operate in a manner it perceives as more suitable (Cuban, 1986). This means that the innovation remains locked ineffectively in a postadoption limbo.

Those technologies not adopted have only marginally met the needs of teachers, but some teachers use those technologies willingly. A tool that most teachers might reject because of inflexibility or lack of time allotted in a class, another might adopt because of its potential for motivation or use as a supplement to curricular material. A technology might meet the same criteria for one's acceptance that prompts another to reject it. Teachers will use those technologies that help them solve problems without eroding their authority. If teachers see a technology as irrelevant, burdensome or an intrusion, they will resist or show indifference. The questions and criteria of the teachers are paramount, and they are bounded by the setting of the classroom and school – the key determinants in how teachers react to innovation and technology (Cuban, 1986).

The glaring reality that reformers typically miss, irrespective of how well-intentioned they might be, is that of the *environment*. The setting creates a powerful influence over the way people behave and interact, including the physical arrangement of the school, the groupings of the students, the number of the students, the time allotted, and the rules of behavior for teachers and students. This also involves the educator's goals or objectives, the most basic of which is to use compulsory attendance to funnel a group of children into an orderly environment in which those children must learn a certain base of knowledge and values. The devices developed to allow the teachers to carry out this mandate include self-contained classrooms, age-graded levels, standard class sizes, and uniform teaching loads.

All of these demands have required a rationing of the teacher's time and energy, which has led to certain practices and solutions for getting the job

done. The arrangement of the room and the desks in it allow for ease of surveillance over the class. The teacher's desk, at the front of the room and near the chalkboard, directs the attention of the students to the teacher, as well as symbolizing who is in control. Certain routines have evolved for establishing order, such as raising one's hand and being recognized prior to speaking, as well as for group instruction, recitation, demonstration, seatwork, and the other functions that typically occur in a classroom. These are all methods permitting the teacher to move the class through the prescribed coursework by the end of the school year. Through the routines and methods they have developed, teachers have found practical solutions to the complicated problems inherent in the school and classroom environments. Teachers *will* use technological innovations, but only if, given the constraints of the environment, those technologies show themselves to be efficient, effective ways to address the demands of the job (Cohen, 1988; Cuban, 1986; Saettler, 1990).

The innovations most widely adopted have been those requiring the fewest adjustments or creating the fewest problems, fitting most easily with the existing structure and yielding the greatest benefits for the tasks at hand. An examination of those innovations put to the most widespread and frequent use would support this thesis. Chalkboards and textbooks have gained acceptance and use because their durability, simplicity, and flexibility have met the demands that teachers must face in their daily tasks. Radio and television, on the other hand, have offered much lower value to the teachers because of the frequent logistical problems and limited flexibility of the media, resulting in more selective and less frequent use than other available instructional tools. Earlier computer-assisted instruction that depended on one central computer was cumbersome and ineffective. Newer micro-computers are more easily molded to the schools because they are less expensive, more flexible, and create fewer organizational problems than their ancestors; they have, therefore, achieved much more widespread use than the CAI of the 1960s and 1970s (Cohen, 1988).

The perverse logic is that the most flexible innovations are generally used in the most inflexible ways, because the flexibility of the instructional technology makes it that much more easily adapted to the core's organization. In other words, the flexibility that is believed to be the key to the revolutionary impact of technology may, in fact, be responsible for the system's stasis. The rigid, whole-class approach of lecture-recitation-seatwork that early 19th century pundits thought would be made obsolete by books, for example, remained the rule; the books were so flexible that teachers simply inserted them into the pre-existing structure. Those technologies that have been accepted have been the ones most flexible, most

easily adapted to the existing system, approach, or learning theory. With no change in the culture and environment of the school, and no change in the learning theory implemented there, technology use will continue to follow a route marked by adoption that is inconsistent and occurs only in novel situations.

Shifting the Paradigm, Installing the Technology

As mentioned already, the research indicates that the potential for computers as an effective learning tool can be realized, and with dramatic and impressive results. However, this occurs only where the technology has been applied to a paradigm that has been designed to allow for or include that given technology. A growing number of researchers believe that the key is shifting the learning paradigms used in the classroom.

For example, one paradigm gaining currency and credibility is known as Situated Learning or Situated Cognition. Situated Learning posits knowledge as a tool, and builds on the idea that knowledge is situated – that is, it relies on the context in which it is used to be fully and effectively learned (McLellan, 1996). Essential to the learning process are three separate but interdependent elements of activity, concept, and culture, which means that the knowledge is best learned when the concepts are developed and actively practiced in the environment or context in which that knowledge will be applied (Brown, Collins & Duiguid, 1996).

The situated cognition model process recognizes eight components of learning (McLellan, 1996). The development of narratives, the first component, can and generally does play a key role in a person's social construction of knowledge. The next stage, reflection, involves the learner consciously grasping the meaning and implications of the task. Cognitive apprenticeship, the third step, is an enculturating phase in which the students actively use the knowledge through social interaction. Collaboration, stage four, primarily involving collective problem solving among the students, follows. All the while, this must be observed and guided by the teacher in an ongoing role known as coaching, the fifth component. Once the base of the knowledge is set, the student moves into repeated practice – area six – that tests, polishes, and expands that knowledge, followed by the seventh area, articulation, which consists of concentrating on specific component skills and of articulating those skills to others.

The eighth and final component in this model is technology, which is vital because of its ability to support the other aspects of the paradigm, its ability to recreate context for the knowledge or skill, and its ability to extend available resources. Situated learning emphasizes engaging in the process within a given learning domain; technology can often effectively create (or

recreate) that domain, as well as enable repeated practice in the skill or enable articulation of the knowledge set.

Situated learning, like many other models, can be supported or enhanced through certain forms of technology, especially when those forms are integral to the model's design. However, one cannot force technology on top of an existing paradigm and expect it to function. In some cases, it will, but – as has been alluded to already in this paper – rarely in the mainstream, and only in those specific cases in which the technology is flexible enough to be adapted to the prevalent existing practices within a given school environment. Without a shift in the paradigm and the organizational structure and environment that will support that paradigm, and without an accompanying investigation of what technologies will best support the new learning approach and how those technologies should be deployed, technology will continue to play an uncertain and mostly ineffective role in education.

A shift in the paradigm may face great resistance, but, once again, teachers cannot be singled out for criticism here. Some researchers (Tobin & Dawson, 1992; Hannafin & Savenye, 1993) have rightly pointed out that the classroom paradigm will overwhelmingly reflect the model that the public expects to see in that classroom. Most of society has grown up in what Lakoff (1987) calls the objectivist model, which maintains that knowledge is a separate entity that can be assimilated empirically. The opposing model, constructivism, posits that knowledge is shaped by the student's life experiences and understanding, is constructed in the student's mind as he or she engages in that knowledge formation, and whatever truth is arrived at is therefore unique to that student (Simonson & Maushak, 1996; von Glasersfeld, 1989). Even if the constructivist model were believed superior by every teacher in a given school, it would still be difficult to implement that paradigm because so much of society had been oriented toward the objectivist position (Hannafin & Savenye, 1993).

Other factors also play major roles. As has been discussed, teachers have environmental, social, and cultural constraints within the school itself. The educators are charged by the districts, schools boards, and state legislatures with taking a set number of students through a set curriculum, and doing so within a set period of time. This means the teachers will adopt whatever methods will get the required work done within the required time, and reject anything that hinders or fails to adequately support the endeavor. Additionally, teachers, especially those in public secondary schools, typically face an overload of work as well as a paucity of time and energy with which to do it. Add to this equation the lack of resources public school teachers consistently face – in terms of hardware, software, training, support, the list

goes on – and it is little wonder that so many technologies fail and so few find their ways into regular classroom use (Gormly, 1994).

How to Change

Underlying this paper is the author's position that administrators, policy makers, and technology enthusiasts have all too often simply shoved technology through the front doors of the school, expecting the technology to see extensive use and to effect dramatic improvement in the students' knowledge base and skills. It has not happened. As has been discussed, the only technology adopted in the mainstream has been flexible enough to be readily adapted to existing curricula and/or approaches, thereby extending the teacher's ability to move through his or her prescribed coursework in the prescribed time. The preceding pages have shown that the first step in changing this routine must be the development and testing of learning models that work effectively for a given discipline. The next stage must involve development of technology and/or technological approaches that effectively support that discipline and the learning model being used.

Finally, once these first two stages have been ascended, the educators, administrators, and policy makers must work together to develop an adoption/implementation strategy that will effectively place the technology in the hands of the teacher, and train the teacher in the methods through which that technology can best support the teacher's objectives. Given the formidable nature of the task of adoption, an effective implementation strategy is essential. Such strategies do exist, one example of which is called the Concerns-Based Adoption Model or CBAM (Loucks & Pratt, 1973; Hall, Wallace & Dossett, 1973).

The CBAM approach is based upon certain specific givens. First, change does not result from a simple administrative decision or a brief discussion during an in-service training day. Change, rather than being an event, is a process. Secondly, since organizations can only change if the individuals within those organizations change, the individual teachers who will be using the technology must be the focus of any implementation effort. Third, given the individual nature of change, the personal needs, concerns, and perceptions of those who will be using the technology is paramount and must be addressed.

Finally, the feelings and skills of the individuals are an integral part of the change process. As such, researchers have developed a list of seven stages of concern the individual moves through from first exposure to the innovation through regular and integrated use in the classroom. The first three (awareness, informational, and personal) deal with gathering

information on the innovation, and learning what role the innovation will play in the life of the user.

Once use actually begins, the educator turns his or her attention toward the fourth phase of the technology, the management phase: the general logistics, the availability and ease of use of materials, the scheduling of the technology into the class, and the amount of time involved with the innovation's use. The last three stages deal with what impact might result from the technology's use: Examining the consequence it might be having on the learner; engaging in collaboration with colleagues that might provide ideas for more or more efficacious use of the innovation; and refocusing on developing new ideas on how the technology might be used.

A recent collaboration between a national research center (Research and Development Center for Teacher Education at the University of Texas at Austin) and a large school district (Jefferson County, Colorado Public School District) has shown this model to be an effective method of adopting technology in the educational mainstream (Loucks & Pratt, 1973). However, without such a carefully crafted strategy and the resources to provide it, schools typically get no further than the management phase, with teachers becoming mired in the logistics required to implement the technology in their classroom. Once the teacher has decided the logistics of the innovation's use have rendered it ineffective, the innovation is doomed to failure – and through no fault of the teacher.

Conclusions

A growing number of analysts point out that the debate on educational reform during the middle 1980s centered on a technological fix as the solution to ineffective public schools. Since then, graduation requirements have been made tougher, mathematics and science have been pushed, and by 1991, the number of computers in the classroom had risen to one for every 30 students nationwide on average, with 95% of the nation's schools owning at least some computers (Waks, 1991).

Yet, the precise role for technology remains uncertain. The belief in it has outstripped the ability to implement it in meaningful, practical ways, often leading to inadequate planning and ill-advised procurement decisions (Gormly, 1994). In addition, new instructional technology often collides with older approaches. Many educators are desperately trying to keep up with the rapidly changing technologies and their potential classroom applications, but lack the appropriate resources to do so effectively.

In the frenzied rush for technology and its promise, reformers have typically failed to justify those technologies in light of the most essential

aspects of the schools – the needs or restrictions of the classroom environment and the teacher – naively assuming that, because a technology can perform certain tasks under the reformers' idealized conditions, that success will translate into the classroom.

The point missed by much of the education establishment – especially among the administrative ranks – as well as the general public is that technology is not an end, it is a means. The foundation must be built on what works in teaching various subjects to the children, finding what technology fits to achieve those goals, and working with those who will be using the technology – the teachers – to find ways to move it into the classrooms and laboratories. It may well be that the great push of technology for the sake of technology has become counter-productive, obscuring the range of use supported by research and bypassing attempts to solve traditional learning problems in more cost-effective ways. In fact, many problems the teachers face might best be solved through applying existing technology or simply bypassing technology altogether.

The greatest impediments to meaningful use of technology lie not in the technology itself but in administrative and educational areas. Only after educators can establish the basic purposes of schools, the educational goals those purposes entail, the best pedagogical approaches and learning processes to achieve those goals, and the best educational structure to accommodate those approaches and processes, can one turn to the questions of how technology can best serve those goals: What are the best technological tools, what are the best ways to train the educators in the use of the tools, and what are the best ways to get those tools into the classroom so that educators can make the most efficacious use of them.

Even among the most enthusiastic supporters of technology, the realization is growing that certain structural impediments are more responsible for technological failure than supposed hesitancy on the part of teachers. The simple truth is that the social organization of instruction is critical to instructional innovation. Technology provides the opportunity for change, but does not drive it; only organizational changes will allow these opportunities to become reality through providing effective and appropriate incentives. Technology alone reorganizes nothing.

NOTES

1) The themes of *A Nation at Risk* (National Commission on Excellence in Education, 1983) follow: a) loss of U.S. preeminence in technology and ability to compete; b) education linked to success in economics and technology; c)

computer literacy as critical to education and work in contemporary society; d) technology and better software critical to instructional delivery; e) need for periodic standardized tests. Another 1983 study, this one by the National Science Board Commission, *Educating Americans for the 21st Century*, began with the troubling statement: "The nation that dramatically and boldly led the world into the age of technology is failing to provide its own children with the intellectual tools needed for the 21st century" (p. v). The report went on to say that manufacturing, trade viability, research and development, and standard of living were all threatened because the nation was heading toward becoming a technological dinosaur, primarily brought on by the failure of the United States to teach its children to use technology. The new basics of the 21st century that the pundits maintained had to be taught to children included not only reading, writing, and mathematics, but communication, higher problem-solving skills, and scientific and technological literacy – what the report referred to as the "thinking tools" needed to understand the increasingly technological environment.

2) Following *A Nation at Risk*, various task forces formed to study the problems in United States public education and to make recommendations for effective change. The 1986 report to Secretary of Education Terrel Bell, *Transforming American Education: Reducing the Risk to the Nation* (National Task Force on Educational Technology) states that technology, especially computer technology, presents tools that will enable "improving quality of learning, increasing equity of opportunity, access and quality, and ensuring greater cost effectiveness" (p. 58). One of many calling for a total restructuring of American education, the report stresses that acquisition and appropriate application of educational technology represents the key to effective education reform, comparing the potential of educational technology to transform the country to the transformation that resulted from the automobile.

Two other major reports of 1986, *A Nation Prepared,* produced by the Carnegie Forum, and *A Time for Results* developed by the National Governors Association, both cite greater use of technology as being key. In a report developed by the Institute for the Transfer of Technology to Education and sponsored by the National School Boards Association, educational policy consultant Louis Perelman (1987), in suggesting that economic competitiveness and educational productivity are directly linked, asserts that an increase in educational productivity must include use of technology.

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