Abstract

Since the introduction of computers into education nearly twenty years ago, educators have expressed high hopes for the potential of technology to bring about improved teaching and learning. Over the ensuing decades, however, results have been mixed. It is estimated that school districts now spend more than $5 billion a year on technology for schools (Archer, 1998). Nevertheless, the amount of actual classroom change has not come anywhere near the expectations of educators who hoped for a revolution in teaching and learning that might equal the change wrought by technology in the daily activities of business, industry, entertainment, advertising and all other aspects of American life. There have been many reasons given for limited technology integration in schools, but collectively they revolve around three key components: access, teacher professional development and organizational change to support the innovation. The following offers a more generalized examination of how technology may affect an organization through the overall level of adoption, impact on specific patterns of organization in the school itself and the classroom, and the changes in the organizational structure due to technology integration.
Technology Integration in the United States

Stephen Kerr (1996) suggests that in thinking about how technology may affect schools as organizations there are three central factors to consider: 1) The overall level of adoption and acceptance of technology into schools 2) the impact of technology on specific patterns of organization within individual classrooms and schools and 3) organizational changes under conditions of technological change. This paper examines those factors and offers examples of each from a national and, in some cases, an international perspective.

Level Of Adoption And Acceptance Of Technology

The United States continues to invest more than $5 billion annually in education technology (Odem and Griffin, 1999). The pressure is on to measure effectiveness of technology for educators. But how to measure effectiveness of technology is the question. Businesses have struggled to measure the impact on productivity, cycle time, efficiency and the bottom line.

As cited by Provenzo, Brett & McCloskey (1999), in spring 1995, the Office of Technology Assessment reported that there were approximately 5.8 million computers in use in schools in the United States, or approximately one machine for every nine students. These authors also report that American schools have had a tendency to place computers in separate labs, rather than in classrooms. This means there is less of a tendency to integrate the machines with everyday instruction, and the machines are more likely to become part of a separate activity, typically involving drill and instruction exercises. Provenzo, et al (1999) provide more statistics from the Office of Technology
Assessment as they describe high schools that are more likely to have newer and more powerful machines, use more advanced software and link themselves with online information sources:

In 1992, the average high school had 54 computers, whereas the average elementary school had approximately 25 machines. During the early 1990s, computer growth in the public schools averaged about 18% a year. As of 1992, local area networks were in use in about 20% of all public schools in the United States – 16% at the elementary levels and approximately 25% in secondary schools. (p. 8)

International Comparison

A survey in 1984 in England, Wales and Northern Ireland secondary schools by the British Broadcasting Association and the Microelectronics Education Programma, showed an average of 8-10 microcomputers per school, based on a questionnaire return of 432 schools. A more recent study in London primary schools by Hall & Rhodes found that the extent and type of use of microcomputers was very varied, often depending upon the enthusiasm of one or two teachers, or the policy of the headteacher, rather than the amount of hardware and software available in the school (Cox, 1986).

In a report on China’s educational system, David Craig (1996) observes that school administrators held a collective vision for their schools. They were interested in upgrading teacher competencies in technology, locating quality instructional software and securing more private funds for instructional technology.

Seung H. Jihn (1998) investigated technology integration in Korea and found that there are many problems and difficulties preventing effective uses of educational technology in the Korean classroom. One of the main problems Jin discovered is that the school curriculum is not appropriate to integration of technology. Since the introduction
of microcomputers in the schools, the microcomputer has been an object to be studied rather than a tool for supporting learning of other subjects. Most of the computer instruction has focused on developing the knowledge and skills of programming and learning about how computers operate. Jin also cites lack of teacher preparation in technology along with a shortage of software, lack of hardware and equipment such as televisions, laser disk players, CD-ROMS, LCD panels and other types of instructional equipment. In addition to the inadequate hardware and software, a need exists for software developers to go beyond traditional tutorial and drill software. Even though over 5,000 educational programs have been developed in Korea, most existing applications and tutorial or drill and practice program based on a behaviorist approach. Few simulation or problem solving programs that focus on higher order cognitive skill and enhancing critical thinking have been developed.

What about other countries where student achievement is high? As Singapore’s industrialization took off, its education system was adjusted to produce knowledge-based graduates and technicians for its specific industries. As new priority industries required a high level of skills and technology, the government intervened. The Report of the Economic Committee in 1986 endorsed the assumption that the government should create the infrastructure and environment conducive for science and technology development goals for Singapore’s high technology industries (Sing, 1991). The Singapore government is providing $2 billion for instructional technology (IT). Their “Masterplan for IT” emphasizes training the nations’ 23,000 teachers within a four-dimension framework: curriculum and assessment, learning resources, teacher development, and physical and technological infrastructure. The plan is for instructional technology to be
infused naturally into the curriculum as technology becomes a tool to broaden teachers’ repertoire of skills. The computer-to-student ratio is 1:2 with a target of use of those computers 40 percent of class time. (Budnik, 1999).

Access and Educational Equity

Use of the computer and Internet by the general public has mushroomed over the past several years. Accordingly, school use has also increased rapidly. Traditionally, schools have not rushed to adopt innovations, yet survey data indicates that over the past five years they have increasingly adopted computers and the Internet. Therefore, the problem is not that the schools are not embracing these new technologies, the problem is the ever-widening gap that separates students who use computers and the Internet from those who do not. The July 1999 study, *Falling Through the Net* found the chasm separating Internet use between majority and minority, rich and poor, has increased. The gap in Internet use between whites and blacks expanded to over 20 percent in the last year (32.4% of white households versus 11.7% of black households) from 13.5 percent in 1997. The gap between white and Hispanic Internet use in 1998 rose to 19.5 percent from 12.5 percent.

Sutton (1991) addresses the concern for inequalities in access and use of microcomputers in schools. High levels of use for drill-and-practice software for minority and poor students, the widespread availability of relatively cheap drill and practice software, and the ease of integrating this type of software into the curriculum make technology an easy “solution.” Inez Chisolm, Leslie Irwin and Jane Carey (1997) cite studies that support that even when schools with large low socio-economic and
minority population have computers, frequently there is limited availability of varied technology, a disproportionate use of drill-and-practice applications, and defective, inoperative or outdated hardware.

Emhovich (1992) also expresses concern that great care must be taken to provide access to those less privileged than others. She says that already there are disturbing signs that minority children may become doubly disadvantaged in their exposure to ensure that all children have equal access, so that one group does not become computer technology. First, there may be fewer computers in their schools and this lack may be compounded by a corresponding lack of computers in minority homes. She cites an issue of greater concern related to those earlier attributed to Sutton, that when minority schools do receive computers, their use may be limited to the teaching of basic skills with remedial software programs. In contrast, schools with a predominantly majority population are more likely to use computers to teach higher order literacy and cognitive skills through the use of programming languages and sophisticated graphics and simulations tools for mathematics and science. Emhovich relates the faulty assumption that explains this relegation of minority children to this type of instruction as a belief by many educators that children must demonstrate competency in lower level skills before they are ready to progress to more complex cognitive skills. This error is compounded by the fact that competency is equated with high scores on standardized achievement tests.

Sutton (1991) believes that at the rate computer technology changes, attitudes towards the technology may be as important as skills with a specific machine. Individuals who are not anxious, but rather view computers positive and are confident
about their ability to use computers will be more likely to learn whatever new skills are necessary to adapt to changing hardware and software.

The Impact Of Technology On Specific Patterns Of Organization Within Individual Classrooms And Schools

While technology cannot solve every problem facing educators today, there is strong evidence to suggest a positive correlation between student achievement and rich, pedagogically sound curriculum-based technology. Several studies have shown improvement in both standardized student achievement scores and higher qualitative scores when teachers use technology in teaching. *Education Week* devoted its October 1998 issue to the effectiveness of education technology. The issue entitled, *Technology Counts ’98* approaches the technology issue from many perspectives: impact on test scores, policy perspectives, statistics on how education technology is taking hold in public schools and a “State of the States” survey of policies on education technology. Archer (1998) cites the study conducted by the Education Testing Service that documented the relationship between student use of technology and national standardized tests. The study was based on the performance of fourth and eighth graders. There were strong links between the type of technology in use and improvements in scores on the National Assessment of Educational Progress (NAEP) tests. These findings indicated that eighth graders whose teachers used computers for mostly simulations and application performed better than students whose teachers did not use computers. The study revealed that fourth grade students whose teachers used computers mainly for ‘math/learning games’ scored better than those who did not. In every case, gains were higher in the middle schools than in elementary schools.
Archer (1998) reports that researchers concluded that technology can have positive benefits, but the benefits depend upon how the technology is used. The data from the study also indicate that most schools in the United States are not using computers in ways that promote better scores. Prepared teachers and quality instructional strategies cause the technology to aid learning. How teachers use technology in their teaching – drill and practice versus simulations of higher order thinking - is the key (Archer, 1998).

Cuban (1986) in Teachers and Machines: The Classroom Use of Technology Since 1920 examined in detail how new educational technologies have been adopted for use in the classroom, and how their use has failed to meet their promised potential. He identified four possible reasons why past educational technologies failed to meet their promised potential:

- Teachers often lack the training and skills necessary to make effective use of instructional technology
- Equipment and media are often expensive.
- Equipment is not always reliable or dependable, often it is not available when needed.
- Instructional material may not adequately fit a student’s instructional needs. (p.18)

The Impact Of Technology On Specific Patterns Of Organization Within Classrooms

Provenzo, Brett & McCloskey (1999) cite studies by Karen Sheingold and Martha Hadley that indicate the environment for teaching is significantly changed by use of computers in the classroom. Surveys of 608 teachers who had experience in integrating computers in to their teaching revealed that seventy three percent of the teachers had used computers five years or longer in their work. Sheingold and Hadley found that nearly ninety percent of the teachers sampled felt their teaching had changed as a result of
introducing computers into their classrooms. Nearly three fourths reported that they could expect more work from their students in terms of their creating and editing their work. Over 70% reported that they spent more time with individual students, whereas 65% reported that they were comfortable with having their students work independently. A total of 63% stated they were better able to present more complex instruction to students; 61% felt they were better able to meet student needs; 52% found themselves spending less time lecturing the entire class; 43% found themselves more comfortable with small group activities; and 40% found themselves spending less time practicing or reviewing material with their whole class. (Provenzo et al, p.13)

Organizational changes under conditions of technological change

Kozma and Croninger (1992) report that over the past decade, school systems of the United States have engaged in an unprecedented buildup of educational technology. Evidence is growth that emerging technologies can facilitate learning. Whether or not they will improve our educational system is another issue. They point to three aspects of school failure that educational technology can successfully address. These include: the gap between in-school and out of school learning, overemphasis on lower order skills and basic knowledge; and low engagement and motivation.

Johnson & Johnson (1996) say that teachers and schools have been very slow in adopting new technologies and very quick in discontinuing their use. These authors and Oppenheimer (1997) describe a cycle defined by Cuban (1996) in which the potential of a technology leads to fervent claims and promises by its advocates. Then its utility is demonstrated by academic research in a small set of classrooms rich with human and technical support. As it is implemented in the classroom, teachers who have little or no
resources attempt to adopt the technology and are frustrated by their failure to make it work, so the use of new technology gradually declines. Oppenheimer (1997) adds that since the teachers never really embraced the technology, no significant academic improvement occurred. Meanwhile, few people questioned the technology advocates’ claims. As results continued to lag, the blame was laid on the machines. Soon schools were sold on the next generation of technology and the lucrative cycle started all over again. Thomas Reeves (1992) describes an analogous situation that often evolves when school administrators buy technology such as computers:

First, they buy the brand and model of computers that yield the largest number of computers for the dollars spent. Then they buy whatever software is available for those computers that they can afford. Finally, they turn the computers and software over to the teacher so they can decide what to do with them. The general failure of computers and other instructional technologies to transform schooling should not be surprising given those circumstances. (p.520).

Salomon, Perkins & Globerson (1991) state that if computers became as central in education as predict they are bound to, the whole culture of school is likely to change, from knowledge imparting to self-guided exploration and knowledge recreation – and such a change would in turn change the place of computers in schools, disclosing important and often unexpected roles for them.

Cuban (1989) addresses the teachers’ and students’ roles and the “nature of the knowledge that should be learned in school . . . The idea that students pose problems, ‘mess around’ with ideas, and inquire, suggests active, involved learners who come to understand how mathematicians and scientists wrestle with problems” (p.219). Cuban continues as he describes the role of the teacher as “guide, coach and gentle pusher, not the sole source of disciplinary (in both senses of the word) authority” (p. 219).
Cuban envisions learning with technology as the students’ knowledge of subjects being “constructed and owned as a consequence of robustly interacting with the computer, teacher and classmates” (p. 219).

David and Roger Johnson (1996) suggest that the failure of schools to adopt available instructional technologies and to maintain or continuously improve their use may be due in part to two barriers: (a) the individual assumption underlying most hardware and software development and (b) the failure to utilize cooperative learning. These authors describe the automatic assumption on the part of hardware and software designers that all technology-assisted instruction should be structured individualistically. However, they state that the best way to conduct technology-assisted instruction is to embed it in cooperative learning. Charles Crook (1998) says that teachers have been encouraged to foster more collaborative structures for learning. In North America, an external pressure to support group work seems to have arisen from a determination to sustain and succeed with ethnically diverse classroom communities. Crook (1998) contends that computers offer a medium in which abstract material can be rendered accessible through creating visible and manipulable representations. He states, “. . . collaborative learning is all the more effective when the participants are able to orient towards such referential anchors and jointly witness the effects of manipulations upon them” (p. 244). Johnson & Johnson (1996) define technology-assisted cooperative learning as the instructional use of technology combined with the use of cooperative learning groups. Cooperative learning tends to promote positive attitudes toward technology-based instruction. A key aspect of technology assisted instruction is the student attitudes generated by the experience. Students are more likely to learn from and
to use technology based instruction in the future when their self-efficacy toward technology and attitudes about technology-based instruction are positive. Schools eventually may have to make greater use of appropriate technologies and cooperative learning. It may be that technology assisted cooperative learning best prepares students to live in the modern world.

Robert Holloway (1996) cites two surveys of teachers regarding attitudes toward educational technology. A survey of 231 teachers by Wiley in 1992 wherein he found that teachers may view educational computing as an “add-on” to the existing curriculum, caused Wiley to project that teachers’ concerns may be redirected through staff development programs that are aligned with those concerns. A study of 400 Kentucky elementary teachers concluded that organizational factors supportive of educational technology were directly related to the frequency with which instructional technology was used in the classroom. Those factors cited in Henry’s 1987 study include: 1) the availability of technological hardware in the classroom, building and the district media center, in that order; 2) the amount of teacher input into the purchase of hardware and software; 3) the level of administrative encouragement; and (4) the amount of training teachers had in the use of each medium (Holloway, 1996).

Wager (1992) states that educational technology is not simply computers and videodiscs but rather a broader vision of the context and process for learning. The technology of instructional design extends the technology of machines. When properly used educational technology can enhance the presentation of content and stimulate the information-processing capabilities of students. Certainly, technology integration goals for international education should be to enhance content and encourage critical thinking.
and crucial problem solving skills as we increase the capacity of our students to use technology as a learning tool. Organizational changes must facilitate technology integration and must be accepted as part of the connection of technology and school culture. Holloway (1996) quotes Cuban (1993) from *Computers Meet Classroom: Classroom Wins:*

>Schools are substantially different from businesses and industries and other organizations. In one way, schooling is less vulnerable to electronic technologies than these other institutions because 'certain cultural beliefs about what teaching is, how learning occurs, what knowledge is proper in schools, and the teacher-student relations' focus on human rather than machine interaction (p 86). Cuban argues that schools are not culturally compatible with technology but that there are external pressures to adopt it. (p.1127)

Holloway provides further evidence of social and organizational effects on technology use with what he refers to as "empirical grounds" for school culture being the determining factor. Referring to Mehan's (1985) study, Holloway concludes that social change as a function of technology is a function of many issues. He refers to Washington and Bunkley's 1988 survey of teachers and administrators which found that complicated factors influence the fate of computer innovations in schools, particularly in the areas of orientation, communications and support of project decision. A study by Becker (1994b) is cited by Holloway (1996) as he provides a list of what is needed in schools and organizations that support technology using teachers. Conclusions from this study indicate that technology using teachers appear to be in schools:

1. Where there is a strong social network of many computer using teachers.
2. With a full-time technology coordinator on staff
3. In a district that provides teachers with formal staff development for (using tool-based software and (b) using technology . . . in curriculum
4. That have made a long-term commitment to students using word processing . . .in subject-matter classrooms
5. That have policies ensuring equity of access between boys and girls
6. Where pattern of use extends beyond basic math, language arts, and computer literacy to social studies, fine arts
7. That allocate time at school for teacher to use school computers . . . for their own professional tasks
8. That are faced with additional maintenance . . .
9. That need, perhaps most of costly of all, smaller class sizes for computer using teachers. (p. 1127)

As technology use becomes more and more transparent in educational settings, integration of technology into the curriculum will become institutionalized and accepted as a part of school culture. As technology innovations continue to develop exponentially and are more and more available in school settings, the three key components of access, teacher development and organizational change will be the forces that support integration of technology into school curriculums, both in the United States and all over the world.
References


