DOCUMENT RESUME

ED 373 759 IR 016 769

AUTHOR Schneberger, Scott L.; Jost, Karen Lee
TITLE Educational Technology Adoption: An Information Systems Perspective.
PUB DATE 94
NOTE 13p.; In: Proceedings of Selected Research and Development Presentations at the 1994 National Convention of the Association for Educational Communications and Technology Sponsored by the Research and Theory Division (16th, Nashville, TN, February 16-20, 1994); see IR 016 784.
PUB TYPE Information Analyses (070) -- Reports - Evaluative/Feasibility (142) -- Speeches/Conference Papers (150)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS *Adoption (Ideas); Definitions; Design; Educational Change; *Educational Technology; *Information Systems; Models; *Program Implementation; Teacher Attitudes; Technological Advancement; Theories; Theory Practice Relationship; User Needs (Information)

ABSTRACT

Concentrating on the adoption and implementation of educational technology, this paper outlines and compares the conceptual definitions of educational technology (ET) and information systems (IS). Adoption and implementation models and frameworks are discussed, and similarities and differences between IS adoption and implementation and educational change are considered. ET and IS definitions focusing on devices, people, knowledge, and processes suggest a theoretical linkage between ET and IS application and adoption. Knowledge acquired about IS adoptions may be helpful to ET implementation in the future. Research on educational change has also produced knowledge of factors that are associated with adoption and that affect implementation. However, the factors and processes associated with successful ET adoption will likely have different relative weights than the factors and processes in previously researched successful IS adoption. One important factor for ET adoption that should be adopted from the IS factor model is that of involving users directly in the design process. Bottom-up and top-down involvement and support are required. (Contains 30 references.) (SLD)

Title:

Educational Technology Adoption: An Information Systems Perspective

Authors:

Scott L. Schneberger
Karen Lee Jost, Ph.D.

Georgia State University
University Plaza
Atlanta, GA 30302

777

Introduction

Educational reform is a leading topic in socio-political debate, and was one of the key issues in the latest U.S. presidential election. Many educators envisioned educational technology (ET) becoming a large part of that reform. Heinich (1970), for example, foresaw a major role for educational technology as a tool to support teachers, as a replacement for teachers and a conduit for directly educating students, and/or as a means to forming a partnership with teachers whereby technology delivers routine instruction and teachers focus on planning and educational management. Indeed, interest in educational technology and some practical successes during the last 50 years led educational technology to become a unique academic and professional field. The field has academic departments and courses, professional organizations, journals and conferences, academic professionals who identify themselves as educational technologists, and of particular significance, a considerable amount of scientific research. One could easily assume that with so much interest in educational improvements, with so much potential for educational technology as part of the expanding information age of technology, and with all of the research within the field of educational technology, deep and broad improvements in established education would have resulted.

Many educational technologists, however, lament what they perceive to be few implementation successes and a decidedly low impact of educational technology on established education (Reigeluth, 1989; Winn, 1989; Gentry and Csete, 1991; Heinich, 1991a). Educational technology is said to be an applied field, yet its knowledge, based on empirical research, is not applied by practitioners to the degree expected.

Many authors, publishing within the field of educational technology, have analyzed the problem and blamed a wide range of factors. Some view teachers themselves as the culprits; citing the idea that teachers are threatened by perceived professional irrelevance that would cause them to naturally resist educational technology (e.g. Heinich, 1991a). Other authors blame simple bureaucratic inertia and lack of educational funding (Gentry and Csete, 1991). While there have been many accusations concerning weak adoption of educational technology in general education, some educational technologists criticize research as a malefactor, it is either too descriptive and not prescriptive enough (Clark, 1989), it is based on too many confusing or conflicting theories (Ross and Morrison, 1989), the research simply lacks external validity to everyday situations (Reigeluth, 1989), or that it fails to take advantage of related research in other fields (Clark 1989).

The problem of innovation and adoption (and ruminating self-examination) is not, however, unlike what occurred in the information systems (IS) field during the early 1980s before the widespread proliferation of personal computers and readily available commercial software packages. A considerable amount of information systems research and writing has been done on who, what, when, where and why (or why not) information systems are adopted, including research on why some information systems are adopted but then not used. It is unlikely that the problems with the adoption of educational technology innovations are entirely unique to education and educational technology. Instead they include problems commonly faced by proponents of any new technology.

This paper concentrates on the how problems of educational technology adoption. It presumes the validity of educational technology research on effective and efficient innovations and focuses instead on the adoption and implementation process and its factors. This paper outlines and compares the conceptual definitions of educational technology and information systems and relates the histories of ET and IS adoption. It outlines and explains information systems adoption paradigms, models, and frameworks and suggests similarities and differences between IS adoption/implementation and educational change. Finally, this paper discusses educational change and what can be learned from information systems adoption models.

Definitions

One of the immediate issues in discussing the educational technology adoption problem are the varying definitions of educational technology. The Association for Educational Communications and Technology (AECT) defines educational technology as

a complex, integrated process involving people, procedures, ideas, devices and organization, for analyzing problems, and devising, implementing, evaluating and managing solutions to those problems, involved in all aspects of human learning. (AECT, 1977, p.59)

Others define educational technology as a methodology or set of techniques (Cleary et al., as cited by Gentry, 1991), a "body of knowledge" (Dieuzeide, 1971, p.1) and as procedures and devices (Silverman, as cited by Gentry, 1991).

Instructional technology (IT), a phrase frequently used interchangeably with educational technology, often carries two connotations. The definition stated by the Presidential Commission on Instructional Technology (1970) includes both the view of instructional technology as

the media born of the communications revolution which can be used for instructional purposes along side the teacher, textbook, and blackboard. (p.19)

and as

a systematic way of designing, carrying out, and evaluating the total process of learning and teaching in terms of specific objectives, based on research in human learning and communications, and employing a combination of human and non human resources, to bring about more effective instruction. (p.19)

Engler (1972) similarly defines instructional technology within two categories, the first as "hardware-television, motion pictures, audio tapes and discs, textbooks, blackboards, and so on" and secondly as

a process by means of which we apply the research findings of the behavioral sciences to the problems of instruction. (p. 59)

One should not view these definitions of educational technology (and instructional technology) as nebulous, contradictory or exclusive definitions, but rather as inclusive definitions to bound the area of interest. By combining the essence of the definitions above (and others cited by Gentry, 1991), this paper defines educational technology as

the application of people, devices, knowledge, and procedures for efficient and effective education.

The significance of combining the varying ET and IT definitions is a clear correlation with a textbook common definition of computer-based information systems (e.g., Davis and Olson, 1985; Laudon and Laudon, 1993):

devices (computer hardware, software and communications), people, and procedures for organizing, storing, accessing, and maintaining information.

The definitions of educational technology and information systems identically focused on devices, people, knowledge, and process suggest a theoretical linkage between ET and IS application and adoption. The problems and issues associated with adopting information systems appear to have direct bearing on the problems and issues with adopting educational technology. Information systems research on adoption, therefore, would seem to offer rich insight and direction for fruitful educational technology adoption research. If the theoretical and practical parallels between ET and IS adoption hold, what information systems has learned about IS adoption may be what educational technology can benefit from in the future.

Educational Change: A Summarized History

Fullan (1991) identifies four distinct historical phases in educational change: adoption (1960s), implementation failure (1970-77), implementation success (1978-82), and intensification versus restructuring (1983-90).

Fullan's first phase (adoption) came largely as a result of Soviet success in launching a satellite in 1957 (years before the U.S.). The subsequent "Sputnik crisis" led to large-scale curriculum innovations, technologically-oriented instructional systems, and the advocacy of inquiry-oriented and student-centered instruction. In the rush to meet the crisis, according to Fullan, the emphasis was on how many innovations could be adopted, the more the better as a mark of progress. During this period instructional systems were researched and developed. Significant federal funding for R & D laboratories, mandated evaluation of federally funded educational projects, and the redefinition of audiovisual instruction to include instructional development and technology gave the field of educational technology increased visibility and credibility with educators.

During the 1970s, however, innovation got a "bad name." According to Fullan, the 1960s' innovations had been adopted haphazardly with little follow-through, leading to pronounced implementation failures. By the end of the 1970s, nevertheless, there were some significant, well-documented successes that provided important frameworks and theories for comprehensive educational reforms. The comprehensive reform movements that began in 1983 (as a result of the watershed document A Nation at Risk by the National Commission on Excellence in Education) took many approaches, including the use of educational technology.

The advent of microcomputers in the 1980s appeared to offer the dawn of a new era with computer-based instructional systems. The wide availability of relatively inexpensive desktop computers, the capabilities of computer-driven media, and the inherent ease of developing, using, and improving software, provided a ready vehicle for applying educational technology. By 1989, 76,395 of the 79,693 U.S. public schools had two or more microcomputers, averaging about 20 per school (Quality Education Data, 1989). Their use, however, was primarily for administrative and clerical applications and not for the process of teaching and learning. The most common educational use of microcomputers was limited to teaching computer "literacy" (Ely, 1991). Higher education wasn't reported as any better; the average U.S. university, in terms of its use of information technology in teaching, was substantially behind the typical elementary and secondary school (Newman, 1989 as cited by Ely 1991).

The Information Systems Adoption Problem: A Brief History and Comparison to the Adoption of Educational Technology within Education

Although electronic computers were used for military purposes in the 1940s, the public application of computers for information processing began in 1954 when one of the first computers was installed to process payroll at a large U.S. corporation (Davis and Olson, 1985). There have been three generally recognized eras in information systems adoption.

The first era was from 1954 to about 1964 when computers were used for accounting and clerical applications in major organizations. Information systems were very difficult to use and expensive. Very few people understood how they worked, even fewer knew what to do with them. There was a wealth of research and theory that predicted enormous benefits from computers in everyday business and personal life, far beyond accounting and clerical use, but potential users and those in management positions could only wonder at the futuristic predictions while continuing traditional work habits. With considerable simplification, this era could roughly equate to the adoption of educational technology innovations in education prior to 1983.

During the second era, from around 1965-1980, the breadth of applications expanded due to improved general purpose programming languages. Major businesses saw computers as a strategic weapon, or at least an image maker, and management began to see the potential efficiency benefits from computers. There were large investments in computers and one-of-a-kind application software. Computers were ensconced within glass "throne rooms" tended to by computer specialists who were intermediaries to users of computed data. Users still didn't understand computers or their potential, but they began to be exposed to the effects of computing. People were mostly forced to adapt to computers and, increasingly, to depend on them for record keeping as well as finance and accounting. These systems were designed by computer specialists who tended to oversell capabilities, had little understanding of user needs, and increasingly built systems that either didn't work, went way over budget, or users wouldn't use. Management perceived the importance of computers, but not how to apply them. As the chief strategist for a major U.S. bank said: [Computer] technology is our top strategic concern, not because it outweighs everything else, but because we are unsure what to do with it. Although we have a strategy for the marketplace, the technology issues seem to be eluding us. We can't seem to grasp the bigger picture (Parsons, 1983).

Information systems academics and professionals bemoaned the dirth of effective IS applications taking advantage of empirical research, while management complained that IS research wasn't practical enough or relevant.

This second IS era seems to correlate with the present state of educational technology research, development, and adoption. During the 1980's, educational technologists also foresaw the importance of the use of technology in education. Educational software increased in availability and to become more "user-friendly." Innovators, however, made mistakes similar to IS designers. Educational programs and products have often been designed by specialists who did not understand the user (teacher) or the classroom learning environment. These innovations, therefore, were not implemented as the designers intended.

The third IS era began with the advent of microcomputers around 1980. The entire mindset of users adapting to computers was reversed as powerful applications that adapted to users were mass-produced and made commercially available. Moreover, non-procedural programming languages allowed non-programmers to write software specifically tailored to their needs, conditions, and location. Simultaneous communication innovations that digitally tied computers together allowed the full potential (widely predicted by researchers in the 1940s) of computers and IS to overcome time and distance. For most industries, information systems were no longer a service or simply a medium for information, it had become the core impetus for an entire re-engineering of organizational processes. The second era issues about what can be done with information systems became third era how issues as new, practical applications spread. Information systems researchers began to struggle just to keep up with IS practice, let alone perform research that isn't obsolete before it's published.

This third IS era parallels current trends in educational technology in the 90's. Given the theoretical and practical parallels between educational technology and information systems, educational technology should explore information systems research on adoption and implementation for insights and guidance.

Information Systems Adoption Theory and Research

Information systems research on IS adoption and implementation has been ongoing since the 1950s with the earliest computer system applications. By the 1980s, implementation was one of the four most heavily researched areas within the discipline of information systems [Culnan and Swanson, 1986]. Two basic adoption paradigms were used for research: factors and process.

Factor Paradigm. The factor paradigm, the dominant paradigm in information systems implementation research, sought to identify and relate the many factors involved in IS implementation success, the what behind successful adoption. Six key variables have been identified from scores of empirical research and analysis efforts:

1. organizational need and support
2. user personal stake in success
3. user assessment of system and organizational support for it
4. user acceptance of system
5. use of system
6. satisfaction [Lucas, Ginzberg and Schultz, 1990].

These factors are linked into a generic model for IS implementation as shown in Figure 1 found in Appendix F.

In this model, management support for a system, organizational changes required as a result of the system, and the urgency of the problem the system is supposed to address combine to affect the user's perceived stake in the system's adoption. User stake, in turn, influences user perception about the system (how efficiently and effectively it works toward the user's goals) as well as the organizational support behind the system (e.g., corrective maintenance, improvement, supplies, etc.). The user's perception of the system and its organizational support in turn directly affects the user's acceptance of the system, in addition to the technical characteristics of the system and the characteristics of the user. User acceptance, overt organizational support, and the user's personal stake in the system then determine how (or whether or not) the system is used. Experience using the system then directly determines satisfaction with the system from a user and organizational standpoint. Also generally believed to be important factors (but not empirically confirmed with strong data or consistently among researchers) are: user knowledge of the system purpose, user decision making style, user job characteristics, user/designer joint system development, and user knowledge of the system (Lucas, Ginzberg and Schultz, 1990). Underlying the entire model is the assumption that user acceptance and use are voluntary; the model changes considerably when system use is mandatory.

Under the IS factor implementation model, adoption and successful implementation largely depend on:

1) gaining support and commitment from the user's management (e.g., funding, job re-design, organizational changes, rewards and incentives, operational support and training)

2) seeking out potential users as early adopters who have a significant personal stake in the problem the system is designed to address, directly involving them in the design process, designing the system to target their technical needs as well as personal characteristics, and focusing attention on their adoption and early use

3) ensuring that the system addresses user personal stakes in system use.

Process Paradigm. This paradigm for information systems adoption and implementation research addresses the process of organizational change and management support behind system adoption. This paradigm takes the standpoint that systems simply address organizational and user change needs and provide a vehicle to implement those change needs. Therefore, how one implements a technological change is the key in this paradigm to successful adoption and use. Three models are prevalent in the IS adoption and implementation research under the process paradigm: technological imperative, organizational imperative, and emergent perspective (Keil, 1991).

The technological imperative model is based on the sociological assumption that external forces (the environment) cause internal changes, namely technological changes, to user behavior. In consonance with innovation theories, this model revolves around two change process factors: the technological advantage the system provides a user in performing his or her functions, and the system's ease of use. Together, these process factors determine system use. To promote adoption, management ensures that the system provides technological advantages (or at least that the benefits outweigh the detriments) and that the system is technologically easy to use. Management's agents to this end are IS specialists who are trained in systems, the organization, how to elicit requirements, and how to appropriately design systems for the users. This model is consistent under voluntary or mandatory use situations.

The organizational imperative model assumes that people are causative decision makers in anticipation or in response to environmental changes. Successful adoption and implementation therefore depend on successfully managing the decision making and implementation processes. This model, primarily based on the change and innovation work of Lewin (1947), consists of three phases. According to this model, successful change depends on unfreezing a situation by creating a climate or motivation for change. The second phase consists of the actual change based on analysis, design, development, implementation and training for a system and the organizational changes that must accompany the system. The final phase requires refreezing by institutionalizing the new system (with resulting organizational stability). This model (as shown in Figure 2) emphasizes that an organization with stable political, personal, and social coalitions must first be disturbed before change can be accepted. Although there are many roles (e.g., the user, management, IS developers), management plays the key organizational role in directing the change process.

(Figure 2 found in Appendix F)

The key to adoption according this model, therefore, is management awareness of the need for change, awareness and support for a change vehicle (the system with attendant personnel, data, process and organizational structure changes), determination and follow-through on changes, and institutionalization of the changes. While this model is associated more with mandatory than voluntary IS adoption, it can apply equally to both situations. Based on the managerial approach to implementing the change, management can serve as a catalyst to user change as well as an orchestrator.

The final model under the process paradigm is the emergent perspective model that assumes people and technologies interact in unpredictable ways. What's important is perpetually adjusting that interaction in response to uncovered barriers to success (as shown in Figure 3) (Leonard-Barton, 1988). The key point of this model is that there must be mutual adaptation between technological systems and the organization (including the organizational structure, its management, support, and the users). Change is assumed to be the norm, whether from internal or external environmental forces. No technological system, the model presumes, can ever satisfy all organizational needs forever and will therefore require continual, incremental changes. Likewise, no organization can remain static in light of technological changes or opportunities provided by systems.

(Figure 3 found in Appendix F)

The key to adoption in this model is the initial deployment of a system, followed by orchestrated monitoring and adaption. Management and users must be willing to innovate and to take risks on the initial adoption and implementation with the understanding that problems will occur. Management and users must also be willing to invest resources (e.g., time, personnel, budgets) to identify and analyze implementation problems. Most importantly, they must be willing to continually implement system and organizational changes in a perpetual cycle of change, analysis, and correction. In organizational terms, this is conflict management, an essential feature of organizational management that entails managerial processes, structure, and content.

These information systems adoption and implementation paradigms, models, factors and processes provide ample suggestions for how to increase and improve successful educational technology implementation in education, as well as provide plentiful opportunities for research.

Educational Change Theory and Recommendations to Educational Technology Adoption and Implementation

Research on educational change has also produced knowledge of factors associated with adoption and affecting implementation. Fullan (1982) synthesized existing information and reported the factors contained in Tables 1 and 2 below.

FACTORS ASSOCIATED WITH ADOPTION

1. Existence and quality of innovations
2. Access to information
3. Advocacy from central administrators
4. Teacher pressure/support
5. Consultants and change agents
6. Community pressure/support/apathy/opposition
7. Availability of federal or other funds
8. New central legislation or policy (federal/state/provincial)
9. Problem-solving incentives for adoption
10. Bureaucratic incentives for adoption.

Table1. Factors Associated with Adoption (Fullan, 1982, p.42).

FACTORS AFFECTING IMPLEMENTATION

A. Characteristics of the Change
1. Need and relevance of the change
2. Clarity
3. Complexity
4. Quality and practicality of program (materials, etc.).

B. Characteristics at the School District Level
5. The history of innovative attempts
6. The adoption process
7. Central administrative support and involvement
8. Staff development (in-service) and participation
9. Time-line and information system (evaluation)
10. Board and community characteristics.

C. Characteristics at the School Level
11. The principal
12. Teacher-teacher relations
13. Teacher characteristics and orientations.

/

D. Characteristics External to the Local System
14. Role of government
15. External assistance.

Table 2. Factors Affecting Implementation (Fullan, 1982, p.56)

When comparing the factors considered in educational change (above) to the IS Implementation Factor Model, a number of apparent consistencies can be noted. An important difference is that the characteristics described as affecting the adoption / implementation process in education are stated and treated in a static manner. What is omitted is any consideration of organizational change. Even the mutual-adaptation perspective which considers implementation as a process in which both the user and the innovation adapts or changes, defines the user narrowly, and does not consider changes which may be necessary at the organization or the larger systems level.

Educational technology adoption research and practice should also bear in mind that educational systems have a characteristic rarely seen in general organizations used in information systems research. Educational systems are professional bureaucracies with a unique organizational structure, unique coordinating and controlling apparati, user roles and culture, communication channels, flow of decision making and authority, and situational factors. For example, information systems factor research consistently reveals management support as the most important, overriding factor in IS adoption and implementation success, but the role of management in a professional bureaucracy is small, existing mainly to provide resources to the professionals (i.e., educators), resolve conflicts among the professionals, and liaise with the external environment. In a professional bureaucracy, a successful decision to adopt an innovation won't likely be made by the administration alone, it will be made and carried out by individual professional educators. This characteristic does not negate ET application of IS adoption models, however, it only suggests that the factors and processes for successful educational technology adoption will likely have different relative weights than the factors and processes in previously-researched successful information systems adoptions.

There also exists an important difference between the use of new information systems and the implementation of new programs, products, or technologies in education, at the level of the teacher. The way that a teacher adopts and adapts an instructional innovation is affected by his or her personal constructs concerning learning and instruction (Jost, 1992). In addition, classroom instruction includes social interactions and constructions which influence both teacher's thought processes and actions.

User acceptance and use has consistently been identified as essential to information systems adoption. Given the professional bureaucracy structure of the educational system, professional educators rightly have the authority and discretion to adopt or not adopt innovations for teaching, they're hired because of their expertise in education. An important factor to improve success should be adopted from the IS factor model: directly involving users in the design process and designing systems that target their needs and characteristics. Without consideration of the user, support and incentives, widespread user acceptance by existing educational professionals is unlikely to occur. In professional bureaucracies, attrition or replacement is the most common means of organizational sea changes, in addition to changing the standards of who can newly enter the profession, changing what individuals learn in training for the profession, and re-educating those professionals who are willing to be re-educated (Mintzberg, 1993). Re-educating must take into consideration the issues of conceptual change and role changes as well as technical and curricular competencies.

Education systems and educational change involve complex and dynamic interrelationships. We must expand our understanding of mutual adaptation to include changes in the innovation, the teacher, the organization and the system. Successful change, particularly change involving sophisticated and pervasive uses of technology, requires both bottom-up and top-down involvement and support.

REFERENCES

Association for Educational Communications and Technology (1977). The definition of educational technology. Washington, D.C.: AECT.
Clark, R.E. (1989). Current progress and future directions for research in instructional technology. Educational Technology Research & Development, 37 (1), 57-66.
Cleary, A. et al. (1976). Educational technology: Implications for early and special education. New York: John Wiley and Sons.
Commission on Instructional Technology (1970). To improve learning. A report to the President and the Congress of the United States. Washington, D.C.: Commission on Instructional Technology.
Culnan, M.J. and Swanson, E.B. (1986). Research in management information systems, 1980-84. MIS Quarterly, 10(3), 289-301.
Davis, G.B. and Olson, M.H. (1985). Management information systems (2nd ed.). New York: McGraw-Hill.
Dieuzeide, H. (1971). Educational technology: Sophisticated, adapted and rational technology. Series B: Opinions (No. 30). Paris: International Commission on the Development of Education, UNESCO.
Ely, D.P. (1990). Trends and issues in educational technology, 1989. In G. Anglin (Ed.), Instructional Technology.(pp. 34-58). Englewood, CO: Libraries Unlimited.
Engler, D. (1972). Instructional technology and the curriculum. In F.J. Pula and R.J. Goff (Eds.), Technology in education: Challenge and change. Worthington, OH: Charles A. Jones Publishing Company.
Fullan, Michael (1991). The New Meaning of Educational Change (2nd ed.). New York: Teachers College Press.
Fullan, Michael (1982). The Meaning of Educational Change. New York: Teachers College Press.
Gentry, C.G. (1991). Educational technology: A question of meaning. In G. Anglin (Ed.), Instructional Technology. (pp. 1-10). Englewood, CO: Libraries Unlimited.
Gentry, C.G. and Csete, J. (1991). Educational technology in the 1990s. In G. Anglin (Ed.), Instructional Technology. (pp. 20-33). Englewood, CO: Libraries Unlimited.
Heinich, R. (1970). Technology and the management of instruction. Washington, DC: Association for Educational Communications and Technology.
Heinich, R. (1991a). The proper study of instructional technology. In G. Anglin (Ed.), Instructional Technology. (pp. 59-81). Englewood, CO: Libraries Unlimited.
Jost, K.L. (1992). The implementation of technology in the calculus classroom: An examination of teacher beliefs, practice and curriculum change. (Doctoral dissertation, Syracuse University). Dissertation Abstracts International, Order no. 9229677.
Keil, M.J. (1991). Managing MIS implementation. Unpublished doctoral dissertation, Harvard University Graduate School of Business Administration.
Laudon, K.C. and Laudon, J.P. (1993). Business information systems (2nd ed.). New York: Dryden Press.
Leonard-Barton, D. (1988). Implementation as mutual adaptation of technology and organization. Research Policy, 17, 251-267.
Lewin, K. (1947). Frontiers in group dynamics. Human Relations, 1, 5-41.
Lucas, H.C., Ginzberg, M.J., and Schultz, R.L. (1990). Information systems implementation. Norwood, NJ.: Ablex Publishing Corp.
Mintzberg, H. (1993). Structure in fives: designing effective organizations. Englewood Cliffs, NJ, Prentice Hall.

National Commission on Excellence in Education (1983). A nation at risk: The imperative for educational reform. Washington, D.C.: U.S. Dept. of Education.

Newman, F. (1989). Uneven marriage: The university and the management of information technology. Keynote address presented at the CAUSE National Conference on Managing Information Technologies: Facing Issues, San Diego, CA.

Parsons, G.L. (1983). Information Technology: A New Competitive Weapon. In P. Gray, et al. (Eds.) The Management of information systems. (pp. 473-502). Chicago: The Dryden Press.

Quality Education Data (1989). 1989-90 Catalog of educational mailing lists and marketing services. Denver, CO: Quality Education Data.

Reigeluth, C.M (1989). Educational technology at the crossroads: New mindsets and new directions. Educational Technology Research & Development, 37 (1), 67-80.

Ross, S.M. and Morrison, G.R. (1989). In search of a happy medium in instructional technology research. Educational Technology Research & Development, 37 (1), 19-33.

Silverman, R.E. (1969). Two kinds of technology. Educational Technology, January, p.3.

Winn, W. (1989). Toward a rationale and theoretical basis for educational technology. Educational Technology Research & Development, 37 (1), 35-46.