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ABSTRACT

Realizing the educational potential of computer technology largely depends on developing appropriate policies related to the technology. A Policy Delphi method was used to identify changes in education that are both probable and possible on account of the introduction of computers, and to explore potential patterns for arriving at a desired future. A critical element in the study was the Delphi panel, composed of 18 individuals with a knowledge of computers and a background in education. Data collection included a pilot study followed by three distinct iterations or rounds. Developments identified as probable and undesirable included underuse of equipment, problems related to the allocation of equipment, lack of appropriate software, piracy, confidentiality of files and information, equity, funding, resistance to change, software and hardware inertia restricting implementation of improvements in hardware, migration of human resources, and increased and conflicting demands on educational organizations. Desirable possibilities include development of a local software industry tailored to provincial curriculum, a strong emphasis on computer-related inservice, an awareness of the social effects of computers, and increased parent involvement in school matters. Potential patterns for achieving a desired future include increased software development and evaluation, increased levels of funding, inservice, a recognition of the need for policies related to educational computing, curriclular development, preservice, planning, security procedures, and communication among organizations and stakeholders. Nine major conclusions, from general to specific, are outlined and discussed. References are included. (TE)

Computer Technology and Education:

A Policy Delphi

by

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ABSTRACT

Realizing the educational potential of computer technology largely depends on developing appropriate policies related to the technology. A Policy Delphi methodology was utilized to identify those changes in education which were both probable and possible through the continued introduction of computers as well as explore potential patterns for arriving at a normative (desired) future. Participants in the study panel consisted of eighteen individuals with a knowledge of computers and a background in education. Data collection included a pilot study followed by three distinct iterations or rounds.

COMPUTER TECHNOLOGY AND EDUCATION:
A POLICY DELPHI

Computers have recently become prevalent in our society. Evidence of their impact is increasingly seen in business, industry, education, and the home. It is generally agreed that they are the dominant technological artifact of our time. Lepper (1985:1) reflects the view of numerous writers: ". . . we are currently on the edge of a revolution in technology that may eventually prove more sweeping and significant than any other technological advance in the last 200 years--the revolution that is likely to occur as powerful microcomputers begin to infiltrate our lives. . . ." Masuda (1980) further describes computer technology as fuelling a transformation from an industrial society to an information society. The widespread acquisition of computers by schools is often cited as reflecting this societal transformation. Numerous reports attest to the rapid growth in numbers of computers in the schools of most of the provinces and states (Bork,1984; Morgan, 1984; Petruk, 1985; Weiner, 1984). Computers have generated a great deal of enthusiasm and excitement as schools continue to acquire them at a rapid rate. Shavelson and Salomon (1985:4) identify a major reason for these developments: "For the first time, a genuinely 'thinking' interacting technology, the computer, has become readily available to education. . . . The pedagogical promise of the new information technology is boundless. . ."

Despite the large scale acquisition of computers in schools there is increasing concern that they are having a limited impact on the instructional process (Bork, 1984; Becker, 1984; Ebisch, 1984; Papert, 1979; Shavelson et al., 1984; Sheingold et al., 1983; Weizenbaum, 1979). Kohl (Ebisch, 1984:38) succintly captures two contrasting visions of the potential of computers in education:

> Computers are special, they're not just an electronic version of the same old boring school tools. But they could be used to reinforce the worst practices of schools. . . . The other possibility is that the computer becomes a tool to extend the capabilities of one's mind, a device for modeling possible worlds, for doing scientific simulations, for allowing kids at a very young age to begin to see that you can control variables and understand systems and do these intellectual things visually.

The promising pedagogical vision of computer technology will not be achieved easily. Shavelson and Salomon (1985:4) suggest that: "The impact of the new technology on cognition is not guaranteed. Its impact depends largely on how students and teachers use the new technology." For Lepper (1985:16), the time for research is now: "Yet it seems critical to examine the larger issues, before this technology becomes such an integral part of our daily lives that it will be, as was the case with commercial television, too late to ask critical questions." Representative of much of the questioning in the area related to computers in education are those questions with a futures orientation (Hunter,1984:26). By having a clearer vision of the future, asking critical questions and establishing appropriate policies, we can make better use of this new technology.

Realizing the educational potential of computer technology largely depends on developing appropriate policies relevant to the technology. Dunn (1981:6-24) establishes that historically there has always been a need for information relevant to policymaking. He also observes (ibid.: 24-26) that the industrial revolution and more recently the advent of a "postindustrial society" have accelerated the need for information relevant to policymaking.

A recognized means of generating information relevant to policymaking are policy analysis studies. Quade (1975:4) describes policy analysis as: ". . . any type of analysis that generates and presents information in such a way as to improve the basis for policy-makers to exercise their judgment. . . ." A commonly used technique in policy analysis studies is forecasting. Dunn (1981:195) suggests that forecasting techniques are suited for problems related to uncertainty, especially those that are "messy" or "ill structured." The present study utilized a forecasting technique known as a Policy Delphi. The purpose was to identify those changes in education, over the next five years, which were both probable and possible through the continued introduction of computers, as well as to explore potential patterns for arriving at a normative (desired) future. As previous studies (Barrington, 1981; Sellinger, 1984) had reported problems related to the Delphi technique, an additional purpose of the study was to further refine the Delphi, particularly in the area of maintaining panelist support.

Methodology

Conceptual Framework

In their definition of policy analysis and policy studies Nagel and Neef (1980:15) emphasize the importance of the study of alternative policies: "Policy analysis or policy studies can be broadly defined as the study of the nature, causes, and effects, of alternative public policies." Dror (1971:70) also recognizes the importance of studying alternative policies in a future context: "The establishment of explicit alternative futures assumptions, to serve as contexts for concrete policymaking, is an important contribution to the improvement of policymaking."

The conceptual framework for this study was derived from these and other aspects of the policy literature that relate to establishing policy alternatives. Yeakey (1983:256) characterized policy as ". . . the culmination of action and inaction of the social system in response to demands made on it." She (ibid.:257) later clarified this statement:

> Policy may be either active or passive in form. Actively, it may involve overt governmental action to affect a particular problem; passively, it may involve a decision by government officials not to take action. . . . what a government fails to enact is as significant as what a government enacts, inasmuch as the politics of omission are as indicative as the politics of commission.

Stokey and Zeckhauser (1978:22) represent the study of alternative policies as similar to an economic model wherein there is a possibility frontier and decision makers must decide among the alternatives available. On a basic level, they describe it as a "fundamental choice model" that involves two primary elements:

1. Identifying the alternatives open to the decision maker; and
2. Determining his preferences among these alternatives.

The present study followed this format. First, alternative futures related to computer technology and education were identified, then policy alternatives for achieving a desired future were explored. Essentially the study, using definitions provided by Dunn (1981:143), identified those futures that were plausible, potential, and normative and then explored strategies for arriving at a normative (desired) future.

The Delphi

A Policy Delphi methodology was utilized in the study. A Delphi is an iterative procedure which allows a group of individuals to collectively address complex problems. It is usually future oriented. The study involved three distinct iterations or rounds. The first round identified those changes in education which were either probable or possible within the next five years as a result of the continued influence of computers. The second round involved a rating of the desirability and probability of those changes identified as either probable or possible. The third round explored potential patterns for achieving a normative (desired) future. An essential feature of a Policy Delphi, unlike the more common Conventional Delphi, is that it is designed to explore policy issues and does not strive for consensus.

Critical to the success of Delphi studies is the Delphi panel. The Delphi panel was identified through a two-step selection procedure. In the first step, six prominent educators who represented different organizations were selected on the basis of their involvement with computers. After participating in the pilot study and the first round of the Delphi these individuals were asked to nominate other participants on the basis of supplied criteria. An additional twelve participants were obtained for the study on the basis of nominations received from this nucleus. Hence, participants in the study panel consisted of eighteen idividuals with a knowledge of computers and a background in education. These individuals represented a variety of organizations as well as different levels of involvement in education. Participation included representation from central office, government departments, industry, in-school personnel, and university. A 100% participation rate was maintained throughout the three rounds of the study. Cost constraints delimited the study to the province of Alberta. However, as at the time of the study Alberta was one of the leading provinces/states in terms of computer related acquisition and activity (Jobs, 1985; Petruk, 1985), the environment provided a very suitable setting in which to identify futures oriented policy issues and concerns.

Data Collection and Analysis

Data for the study were collected through a preliminary pilot study followed by a three round Delphi. The instrument used in each round of the study was developed on the basis of information collected in the previous phase.

The pilot study consisted of six interviews. These interviews were designed to explore concerns related to the impact of computers on education and help conceptualize the problem to be explored throughout the Delphi technique. Information obtained in the pilot study was used to develop the Round I instrument.

The purpose of Round I was to identify those developments within education which were either probable or for which there was potential as a result of the continued introduction of computers to education. Data collection in Round I was by way of interview. The interview guide was developed from information obtained in the pilot study as well as the literature. The eighteen participants were asked to consider educational computing and then identify the major plausible and potential futures in the following distinct areas: acquisition and funding, courseware, curriculum, organizations, and teacher training. In addition to the five areas identified participants were asked to comment on any other areas they felt important to the study. Data obtained in the interviews were summarized, categorized, and synthesized in a series of nine steps. This process provided 100 statements about future developments in education as a result of the continued introduction of computers. These statements were used in the development of the Round II questionnaire.

The purpose of Round II was to rate the overall probability and desirability of statements identified in Round I. The questionnaire consisted of the one-hundred statements about the future which were grouped into the following eight categories: acquisition and funding, courseware/software, curriculum, teacher training, organizations, ethical concerns, equity, and other areas. Participants were asked to rate the probability and desirability of each of the statements. Each questionnaire item required two separate responses wherein the respondent had five choices for each response. The choices related to probability were: highly probable, probable, uncertain, improbable, and highly improbable. The choices related to desirability were: highly desirable, desirable, uncertain, undesirable, and highly undesirable. Analysis procedures related to Round II included reducing these five choices to three categories, a positive, uncertain, and negative rating. A frequency count was done for each of the items and the information cross-tabulated. A 3x3 matrix was produced for each item on the basis of ratings of probability and desirability. Table 1 depicts a sample cross-tabulation from one of the items. Seven categories were created from the cross-tabulation on the basis of participant rating of probability and desirability. These categories were used in the development of the Round III instrument.

TABLE 1

Sample Cross-Tabulation of a Round II

Questionnaire Item

V25	COUNT ROW PCT COL PCT TOT PCT	V26 Highly Desirable 1	Uncertain 3	Highly undesirab 5	ROW TOTAL
Highly probable	1	13 100.0 81.3 72.2			13 72.2
Uncertain	3	1 100.0 6.3 5.6			1 5.6
Highly improbabl	5	2 50.0 12.5 11.1	1 25.0 100.0 5.6	1 25.0 100.0 5.6	4 22.2
	COLUMN TOTAL	16 88.9	1 5.6	1 5.6	18 100.0

The purpose of Round III was to identify potential patterns for achieving a normative (desired) future. A questionnaire was again used for this final round. It consisted of twenty-four statements divided into four sections on the basis of categories which had been identified in Round II. Section I included sixteen statements which had been regarded as highly probable as well as highly undesirable. Participants were asked to recommend strategies for reducing the probability of these developments. Section II included four statements which had been regarded as highly desirable with little agreement regarding probability. Participants were asked to recommend strategies for increasing the probability of these developments. Section III included two statements which had been regarded as highly probable with little agreement regarding desirability while Section IV included two statements which had been regarded as highly undesirable with little agreement regarding probability. Participants were asked to make specific comments regarding each of the statements in Sections III and IV. Data collected were analyzed through a seven step procedure which included categorizing, summarizing, and frequency analysis. In addition, participants were asked to consider each of the twenty-four statements and specify the greatest levels of concern from each of the following: provincial, regional, system, school, and university. Frequency analysis was used to analyze this data.

An additional purpose of the study was a further refinement of the Delphi technique. Design features of the study attempted to address problems identified in earlier studies. Particular attention was devoted to addressing the problem of maintaining panelist support (Barrington, 1981:265; Sellinger, 1984:iv, Bright,1978:42). A 100% participation rate was maintained throughout the study. Major design features of the study which may be attributed to achieving this unusually high participation rate include the following: conducting a preliminary pilot study, use of an expanding nucleus nomination procedure to select participants, establishing early personal contact with participants and maintaining that contact throughout the study, procuring panelist support at the commencement of the study, selective anonymity wherein participants knew the names of other panel members while individual responses remained anonymous, field testing instruments, limited use of the mail system, and minimal turnaround time.

Major Findings of the Study

Major findings of the study identified a wide variety of developments which were regarded as both probable and desirable. These developments were described as being either a reaction to technological change or part of a continued technological experiment. Developments which were identified as probable and undesirable included: underutilization of equipment, problems related to the allocation of equipment, lack of appropriate courseware/software, piracy confidentiality of files and information, equity, funding, resistance to change, software and hardware inertia restricting upward capability of hardware, migration of human resources, increased and conflicting demands on educational organizations. Developments identified as desirable with little agreement regarding probability included: development of a local software industry tailored to provincial curriculum, a strong emphasis on computer related in-service, an awareness of the social impact of computers, and increased parent involvement in school matters. Major potential patterns for achieving a normative future included: increased courseware/software development and evaluation, increased levels of funding, inservice, a recognition of the need for policies related to educational computing, curricular development, preservice, planning, security procedures, and communication amongst organizations and stakeholders.

Overall, the Delphi provided useful information for futures oriented planning and policymaking. The findings tended to emphasize that realizing the educational potential of computer technology requires a great deal of activity in the socio-political arena.

Conclusions and Implications

Nine major conclusions, regarding developments in computer technology and education, were based on the findings of the study. They are outlined below along with a discussion of some implications. These conclusions begin with the general and move to the more specific.

1. Computer technology, like other technological developments, has the potential to have positive, negative, or neutral effects on the educational enterprise. The nature of these effects will largely be determined by the actions of educational policymakers.

In addition to identifying benefits, the study identified a number of negative outcomes related to the impact of computer technology on education. Viewing computers as a panacea for all that ails education has the potential to do much harm. A critical role for policymakers is to ask questions related to the negative effects of computer technology. Uhlig (1983:4) supports this issue on a broad level: "What will be the negative side effects of an information-based society?" Also, meaningful computer related changes, as observed by Bernstein (1983:108-109) and Burch (1984:13) must be founded on substantial values if they are to be of lasting worth to education. There is a need for further reflection on those values that are of lasting worth to education.

2. There will be a continued commitment to computer technology. This commitment will be reflected in a continuation of computer related activities at all grade levels. Much of this activity will be justified on the basis of a general technological experiment. Policymakers will continue to assume that computers will improve educational practice. This

improvement will be viewed as taking place within the existing educational structure.

A continued commitment to computer technology will consume a large amount of human and financial resources. Despite this commitment, the findings of this study and the literature (Shavelson et al., 1984:30; Bork, 1984:242; Sheingold et al., 1983:431) express a concern that computer technology is having a limited impact on the instructional process. Clearly, a major challenge lies in further exploiting the potential of computers in education. Exploiting this potential will involve further experimentation, but much of this experimentation will be of little worth unless there is a mechanism for identifying, communicating, and implementing those activities which are truly beneficial to education. Also, while experimentation is necessary, it is inevitable that attempts will be made to use computers for activities for which they are inappropriate. In the process of experimentation a critical question that educators must ask is one posed by Fullan (1982:iv): "Can rejecting a proposed educational program be more progressive than accepting it?" This question should also be asked on a broader level. Peterson (1984:14), for example, suggests that given the massive amount of resources devoted to computer technology we must ask: "Is it worth it?" If future computers are truly capable of delivering what they promise in terms of ease of human interface, they will be as Weizenbaum (Ebisch, 1984:36) suggests, nearly transparent. If this is the case, and computers do indeed become so transparent that we need very little knowledge to actually use them, many of the resources being devoted to computer technology could be allocated to other areas. There is a possibility that many present day computer related activities might soon be described as paralleling the sputnik phenomenon where there was a race to train individuals in areas for which society later had very little demand (Tanner and Tanner, 1980:579-580).

3. Technological change is inevitable. A commitment to technology in education is a commitment to ongoing change. Change will occur as an ongoing continuous process. Rapid technological developments will further compound problems related to change in education. All educational organizations will experience changes precipitated by computer technology.

While meaningful computer related change is possible, realizing the potential of computers largely depends on developing appropriate strategies for dealing with change. One-shot acquisition of equipment or one-shot inservice will not suffice. The rapidly changing technology requires strategies that are ongoing, especially in areas related to acquistion, curriculum and teacher training. In this regard Fullan's (1985:2) notion that change is a process is reinforced by Uhlig (1983:2) in the area of technology: "Technological literacy, unlike some other kinds of literacies, is not an event; it is a continuous process." Key issues for policymakers to address in relation to the "race" with technology is whether we are playing "keep up", "catch up", or if we should even be in the "race". Developing strategies to deal with the rapid process of change presents a mammoth challenge. As Deken (1983:298) observes: "In most areas, the technological capability to produce computer power is far ahead of the human understanding of how to use that power effectively and cooperatively." It is likely that the technological capability to produce new and innovative computer devices will continue to be far ahead of our ability to use them in education. Illustrative of this problem are the many conferences related to computers in education which often more closely resemble an industry "show and tell" more so than they represent any meaningful dialogue related to pedagogy. Mumford and Sackman (1975:v) warn: "Society should deliberately lead and direct the application of computers in the image of its most cherished values and ideals rather than be the unwitting victims of the vagaries of technology and the fluctuations of the market-place." What is required from policymakers is a focus upon developing a clearer philosophy of technology.

Resistance to change is often cited as a major problem facing the implementation of computer technology. Ironically, the technology itself, will foster its own resistance to change as it creates problems related to the "sabre-tooth" curriculum. For example, sunk costs in software, hardware, or training may mean that educational organizations as well as individuals have a vested interest in maintaining certain learning environments. Given that much of the recently acquired equipment is of an older generation, policymakers should address the following questions: Has much of the recent activity, aimed primarily at acquiring large numbers of computers, been inappropriate? Have we already installed a base which will be resistant to further technological change? Has there been an error in identifying the problem related to computers in education as being primarily one of acquisition?

4. Computer technology will provide the impetus to ask basic pedagogical questions related to curriculum and teacher training. There will be continued experimentation related to the organization and dissemination of knowledge.

Each era must rethink its concept of the educated person. Computer technology will provide a powerful impetus to ask questions fundamental to curriculum, including a reconceptualization of both knowledge and the delivery of instruction. Such a reconceptualization will also involve a change in the role of the teacher and will be reflected in teacher training programs. As Henchey (1982:16) suggests, if new curricula are needed, ". . . they cannot be neatly fitted into the existing system of bureaucratic control, institutional structures, professional roles, and educational philosophy." These developments have the potential to profoundly affect education in the long term.

5. Most changes related to computer technology will be external to the learning process. While there will be widespread experimentation, basic curriculum content will remain unchanged. Areas such as business education and computing science will continue to assimilate the technology.

There are two major implications, representing opposite scenarios, related to this conclusion. The first is that meaningful change takes place over time and the next five years will continue to be an assimilation period whereby technology follows the path of least resistance while at the same time improving existing technologies and practices (Naisbitt, 1982:27). These activities will continue to be viewed as providing a foundation for realizing a much greater potential some time in the distant future. Such an interpretation justifies much of the current computer-related activity on the basis of a general technological experiment. The second implication of this conclusion is that organizations may be avoiding meaningful changes through the assimilation of technology (Sheingold et al., 1983:431). If the technology is being assimilated, and little meaningful change is actually occurring, a tremendous amount of resources are currently being wasted.

Somewhat related to this conclusion, is the ongoing implication of attempting to cope with the myth and the reality of computer technology. First, expectations often far exceed the reality of what the technology can deliver. Second, without adequate consideration for the realities of the change process, there is no guarantee that the pedagogical applications which are possible in theory will automatically find their way to educational practice. Decisions that continue to be based on the myth will inevitably lead to disillusionment.

6. Developments related to computer technology will place increased demands on teachers. These demands will be reflected in increased preservice and inservice activity. The teacher's role will gradually begin to change from a disseminator of knowledge to a facilitator of learning.

Charters and Pellegrin (1972:12) cite as one of the major problems related to educational change: "The failure to recognize the severity of role overload among members of the instructional staff when innovation is attempted." The findings of this study as well as Sheingold et al. (1983:427) identify computer technology as contributing to role overload among teachers. Policymakers need first to recognize that this overload exists and then incorporate strategies to deal with it when developing policies related to computer technology and education.

7. All educational organizations will be required to make decisions and establish policies related to computer technology. Many of these decisions will be made at the school, system, and provincial levels. While there is a need for policy at all levels, decisions made at the school level will have the most significant impact regarding the effective utilization of computer technology. Policies will be established both through action and inaction inasmuch as organizations that do not respond to the changing technological environment will be establishing policies through their omission.

It is of critical importance that policymakers recognize the importance of the institutional setting of the school with regards to the use of computers. The findings of the study and the literature on change suggest that successful adaptation of an innovation largely depends on activities at the school level. Berman (1980:222) provides additional insight related to the implications of this conclusion for policy development : ". . . once policy makers dispense with the image that implementation must be uniform for all policy situations, invariable over time, and homogenous across organizational levels, they can search for matching, mixing, and switching strategies to improve policy performance."

8. Continued efforts at realizing the potential of computers will create a number of issues and problems for policymakers. Major problems which will have to be addressed include the following:
(a) underutilization of equipment, (b) allocation of equipment, (c) lack of appropriate courseware/ software, (d) piracy, (e) confidentiality of files and information, (f) equity, (g) funding, (h) resistance to change, (i) software and hardware inertia restricting upward capability of hardware, (j) migration of human resources, (k) increased and conflicting demands on educational organizations.

a. A general public support for computers compounded with generous funding allocations have resulted in the recent acquisition of a great deal of computing equipment. Much of this newly acquired equipment will be underutilized. This underutilization may occur at two levels. First, machines that have been acquired to take advantage of existing grants may see limited physical use. Second, because machines see maximum physical use does not mean that they are being properly utilized. For example, there has been concern over the misuse of games and drill and practice activities (Sheingold et al , 1983:427; Shavelson et al., 1984:`1). Given the large amount of resources being devoted to computers in education there may occur a negative backlash of support for computers should the perception increase that computers are not being properly utilized and that some of the resources could be better devoted to other activities. Large scale acquisition and widespread physical use of the machines does not guarantee that the potential of computers in education will be realized.

b. Computers are being acquired at a rapid rate. They are presently housed in a variety of configurations and used at all grade levels. A major issue is how to allocate equipment in order to maximize benefits from its use. As Peterson (1984:11-12) observes, equal distribution is fair and simple however it often does not provide the critical mass necessary for "ideas and creativity to take off." Configurations such as labs may provide a sense of fairness as well as the necessary critical mass, however, they have the disadvantage of portraying computers as something separate and apart from the curriculum. While increased acquisition will undoubtedly alleviate some of the problems related to access it will also create new ones. For example, as newer generation equipment is acquired who will get access to it? Administrators? Innovative teachers? Designated grade levels or subject levels? Will older generation or underutilized equipment be passed on to less than enthusiastic recipients or merely placed in storerooms? Policies regarding equipment allocation as well as migration will have to be established.

c. Both the findings of this study and much of the literature (Bork, 1984:240; Minister's Task Force, 1983:57-58; Sheingold et al., 1983:429; Komoski, 1984:247; Rockman, 1983:42) strongly suggest that lack of appropriate courseware/software is a major area of concern. This problem has been magnified (Becker, 1984:30) by policies allowing the large scale acquisition of computers. Large scale acquisition, without adequate consideration for applications often results in the use of inappropriate software programs simply because they are readily available (Becker, ibid.:30). The problem of selecting appropriate courseware/software is further compounded by the extremely high ratio of poor quality programs being marketed for use in education (Komoski, 1984:247).

d. Lack of appropriate courseware/software, high costs, inadequate funding, the need for multiple copies of a program, and inadequate copyright laws will all contribute to problems related to piracy. This problem will further reduce the development of quality courseware/software when developers do not receive fair compensation for their efforts. A further problem, in major conflict with a fundamental goal of the educational enterprise, is that students who witness acts of piracy are being encouraged, through example, to participate in activities that are dishonest and illegal.

e. The increased reliance on computers, especially in tasks related to administration, will create problems related to confidentiality of information. These problems will be further compounded by the increased use of computing networks. Two major areas that will have to be dealt with are those related to unauthorized access and the establishment of polices related to access.

f. Computer technology has the potential to remove some of the problems related to equity. For example, improvements in networking and storage capabilities will allow smaller schools to increase their level of service. However there are also problems associated with the equity issue. Two major dimensions of the issue are actual physical access to computers (Sheingold et al., 1983:426; Uhlig, 1983:4), and applications to which students are exposed (Sheingold et al., 1983:42; Shavelson et al., 1984:31). Not all school districts are adopting computers at a similar rate, consequently this will lead to problems for students who do not have a background in computing particularly those who enter post-secondary institutions. Should problems related to equality of access be overcome it will not necessarily lead to equality of opportunity. Decisions related to the allocation and configuration of equipment as well as how computers are used for instruction will vary within districts, schools, and classrooms. There is also the concern that individuals from higher social classes (Fetler, 1984:20) and boys (ibid.:11) are receiving the most benefit from computer instruction. If computers really do make a difference in education, then policies that further address the problem of equity are required.

g. A substantial amount of funds have already been allocated to educational computing, a large portion of which has been designated for the acquistion of equipment. A commitment to technology, if viewed as a process and not an event (Uhlig, 1983:2), will require a significant ongoing commitment of funds in areas such as the acquistion of new equipment, courseware/ software development and acquisition, curriculum, and teacher training. Related to this issue is the problem of obtaining significant levels of funding accompanied with questions related to whether it is worth allocating funds for computing that might be better directed to other areas. Theoretical speculation about the pedagogical promise of this technology is widespread. However there is comparatively little literature which addresses the financial cost of realizing this promise.

h. Computer technology, like other innovations, will meet resistance to change. Fullan (1985:1) describes attempts at initiating change as ". . . a complex dilemma-ridden, technical, sociopolitical process." There is the constant problem of technology having a limited impact on schools, or as Sheingold et al. (1983:431) concluded in their study: "This study more strikingly illustrates the assimilation of technology by school systems than the impact of technology on them." Policymakers must be prepared to deal with the complexities of initiating change. Fundamental to the development of policy (Berman and McLaughlin, 1976:347) is that it be "concerned with more than the mere adoption of change agent projects," and take into account "the critical significance of the institutional setting."

i. Continued new developments in technology will make further change inevitable.

Sunk costs in areas such as hardware, courseware/software, and training may act to reduce an organizations capacity to further adapt to change. For example, an organization with a large investment in existing hardware and software may resist opportunities to adapt to new generation equipment which requires a significant departure from what already exists. Papert (1979:74) describes an additional dimension of this problem when he portrays existing computer related practices as sharing ". . .a model of education which leads them to reinforce traditional educational structures and thus play a reactionary role, opposing the emergence of radically new forms of education." Policies are required which reflect the long term nature of computer related change.

j. Many talented, knowledgeable people in the area of computing will leave education. Some of these individuals will pursue careers in business and industry (Shavelson et al., 1984:29) while others will simply burn out (Sheingold et al., 1983:427). Many other successful computing teachers will also migrate to administrative positions. Policies are required that address the problem of retaining those individuals who can make a positive contribution to education. These policies would also address the problem of role overload and burn out.

k. Computers have simultaneously been presented as a panacea for all that ails education and as having limited significant impact. Kohl (Ebisch, 1984:38) describes them as having the potential to reinforce the "worst practices of schools" or become a "tool to extend the capacities of ones mind." They have also been presented as having little impact on the instructional process (Shavelson et al., 1984:30; Bork, 1984:242, Sheingold et al., 1983:431) yet potentially fostering revolutionary changes in curriculum (Henchey, 1982:13; Papert, 1980:140) and teacher training (Friedman, 1983:16; Minister's Task Force, 1984:36). Weizenbaum (Ebisch, 1984:36) presents computers as ". . .a powerful distraction that will leave the original problems --money, teachers, time, and energy--untouched." Conflicting viewpoints such as these will increasingly be reflected through demands placed on educational organizations. This problem will be compounded by rapid changes in the actual technology. Policymakers will have to continue to address the role of computers in education.

9. Major potential patterns or strategies for policymakers to consider when dealing with the impact of computer technology include the following: Increased software/courseware development and evaluation, increased levels of funding, inservice, a recognition of the need for policies related to educational computing, curricular development, preservice, planning, security procedures, and communication amongst organizations and stakeholders.

Much of the recent activity related to educational computing has been directed at acquisition. However, as this technology continues to place increased and conflicting demands on educational organizations policymakers must recognize the need for further policy development. Enhanced communication and dialogue, for the purpose of establishing policies relevant to technology, will become increasingly necessary. Rapid change, precipitated largely by technology, makes the development of ongoing strategies an essential activity of educational organizations. Realizing the educational potential of computers, in addition to requiring strategies that address technical issues, requires strategies that address people-oriented issues. Developing these strategies will require a huge amount of resources.

Concluding Comments

The rapidly changing technological environment, precipitated largely by the advent of the computer, has accelerated the need for information relevant to educational policymaking. This study provided a means to expose future policy options and issues, however there exists an ongoing need for policy relevant information related to computer technology and education. The focus of educational policymaking ought to deal more with the socio-political people oriented issues surrounding the technology, rather than those issues which are primarily technical.

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