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Computer Technology and Education: Factors Affecting Policymaking

Degree for which thesis was presented
Grade pour lequel cette thèse fut présentée

Ph D

Year this degree conferred
Année d'obtention de ce grade

1985

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COMPUTER TECHNOLOGY AND EDUCATION: FACTORS AFFECTING POLICYMAKING

by

© LLOYD PAUL STEIER

A THESIS

SUBMITTED TO THE FACULTY OF GRADUATE STUDIES AND RESEARCH

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE

OF DOCTOR OF PHILOSOPHY

DEPARTMENT OF EDUCATIONAL ADMINISTRATION

EDMONTON, ALBERTA

FALL, 1985

THE UNIVERSITY OF ALBERTA

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ABSTRACT

Computers have recently become prevalent in our society. Education, in particular, is often described as an area for which this technology holds great potential. Achieving this potential largely depends on policies that are developed related to technology.

The purpose of this study was to identify those changes in education which were both probable and possible through the continued introduction of computers and identify potential patterns for arriving at a normative (desired) future. Specifically, the following questions were asked: What changes are both probable and possible in education within the next five years as a result of the influence of computers? What is the desirability and overall probability of those changes identified as either probable or possible? What are the potential patterns for arriving at a normative future? The study had as an additional purpose a further refinement of the Delphi methodology.

The methodology utilized was that of a Policy Delphi. Data collection involved a pilot study followed by three distinct iterations or rounds. Participants in the study panel consisted of eighteen individuals with a knowledge of computers and a background in education. Participation included representation from central offices, government departments, industry, in-school personnel, and university. A 100% participation rate was maintained

throughout the study.

The 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.

Conclusions were drawn and implications discussed regarding the

following: computer technology having both positive and negative effects, a continued commitment to computer technology, a commitment to technology being a commitment to change, computer technology providing the impetus to ask basic pedagogical questions related to curriculum and teacher training, changes related to computer technology being external to the learning process, increased demands on teachers, all educational organizatons being required to make decisions and establish policies related to computer technology, and the Delphi providing information which is useful in futures oriented planning and policymaking. Also discussed were major issues that policymakers should address as well as potential patterns for addressing the impact of technology.

Finally, some suggestions for further research were presented.

ACKNOWLEDGEMENTS

A dissertation is not a solo endeavour. I wish to thank the following people for their contribution to this research effort:

Dr. J.E. Seger, my advisor, for his guidance and encouragement throughout the study.

Committee members Dr. M. Horowitz, Dr. D.M. Richards, and Dr. E.W. Romaniuk, for their helpful suggestions and interest. A special thanks to committee member Dr. D.A. MacKay for his assistance, suggestions, and continued support.

Dr. F.D. Oliva, for acting as external examiner.

Chris Prokop, computer analyst, for her cheerful assistance with the early quantitative sections of the study.

Those individuals who participated on the study panel and who, in giving so freely of their time and expertise, made the study possible.

My son, Paul, who may not remember, but certainly shared the experience.

Finally, my wife, Marilyn, for encouraging me to undertake the challenge of further study, and for her constant faith and support.

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Chapter 1

INTRODUCTION

Background to the Study

Computers have recently become prevalent in our society. Evidence of their impact is increasingly seen in business, industry, education, and the home. It has been suggested by much of the media that computer technology will revolutionize society. Education, in particular, is often viewed as an area for which this technology holds great promise. 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 if we can master the technology."

Clearly, there are other forces which are also responsible for much of the enthusiasm and excitement. For example, Becker (1984:26) suggests that part of the computer's appeal for education is derived "from the personal stakes of the creators and distributors of computer-related products. . . ." Stephen Jobs, co-founder of Apple Computer, provided an example of this phenomenon when

he (1984:9) reportedly lured successful PepsiCo executive John Sculley to the chief executive position at Apple with the statement: "You can sell sugared water to children the rest of your career or you can change the world a little." One of the significant forces for computer related change in education may be attributed to the efforts of "sugared water" salesmen. O'Brien (1984:42) succinctly describes this force for change: "Madison Avenue sells computers the same way it sells dishwashing detergent and designer jeans."

Historically, other technological developments have been met with enthusiasm, albeit smaller in scale, reminiscent of the present reception of computers. The radio, typewriter, overhead projector, and television are often cited as examples of technologies which were met with much enthusiasm but never quite met early expectations of their potential. For example, a large-scale study done by Wood and Freeman (1932) on the influence of the typewriter in the elementary school classroom strikingly resembles much of the present day literature on computers. The study reported a great deal of enthusiasm on the part of teachers and students, noting that students were arriving early, and staying in at recess and after school, to work on the machines. The study concluded (ibid.:184) that in addition to improving handwriting the typewriter "very probably raises, in some measure the level of achievement in some of the fundamental school subjects. . . ." In addition to perceiving potential applications across the curriculum it also advocated that, in view of the pending increase of the typewriter usage in private life as well as business, all students

should be provided with an opportunity to use the machine. The typewriter never quite achieved the widespread use or promise that Wood and Freeman envisioned.

While comparative references to recent innovations are commonplace, it is generally agreed that the computer is the dominant technological artifact of our time. Lepper (1985:1) cites several authors to support his statement that: "we are currently on the edge of a revolution in technology that may eventually prove much 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. . . ."

The pedagogical promise of this 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 research on commercial television, too late to ask critical questions." Representative of much of the questioning in the area related to computers in education is the question raised by Hunter (1984:26): "What do computers portend for education. . . ?" By having a clearer vision of the future, and asking critical questions now, perhaps we can make better use of this new technology.

Statement of the Purpose

The purpose of the study was to identify those changes in education which were both probable and possible through the continued introduction of computers and identify potential patterns for achieving a normative (desired) future. Specifically, the following questions were asked:

1. What changes are both probable and possible in education within the next five years as a result of the influence of computers?
2. What is the desirability and overall probability of those changes identified as either probable or possible?
3. What are the potential patterns for arriving at a normative (desired) future?

A Policy Delphi study was conducted in order to obtain answers to the above questions. The participant panel consisted of eighteen individuals with a knowledge of computers, a background in education, and who represented a variety of organizations. There were three distinct phases or rounds to the study. First, those changes which were either probable or possible within the next five years as a result of the continued influence of computers were identified. Second, a rating was obtained of the desirability and overall probability of those changes identified as either probable or possible. Third, potential patterns for achieving a normative (desired) future were explored.

The study also had as an additional purpose a further refinement of the

Delphi methodology.

Significance of the Study

Computers have already made a marked impact upon education. A large amount of resources have been devoted to the acquisition of microcomputers and schools have acquired them at a phenomenally rapid rate. Indications are that this growth will continue. While there is agreement that the number of computers in education will continue to grow there is a lack of clarity as to: (1) the concerns we should be presently addressing as a result of their introduction, and (2) the changes and concerns we will likely face in the future.

The study clarifies some of the immediate concerns related to computers in education as well as forecasts future changes and concerns which may occur as a result of the continued introduction of computers. Potential patterns for resolving those concerns and achieving a more normative future are also identified.

There already exist attempts at influencing policy in regard to computers in education. The study provides a further means to expose future policy options and issues for consideration by educational policymakers. In addition, the study provides a conceptual framework from which to identify concerns in formulating future educational policy in relation to computers.

Definitions

Various definitions are supplied throughout the dissertation, however three major terms used in the study are provided below:

Computer

A computer is ". . . any device that can receive and then follow instructions to manipulate information. In any computer, both the set of instructions and the information upon which the instructions operate may be varied from one moment to another." (Burch, 1984:18).

Technology

The practical application of scientific research and discovery.

Education

In the context of this study education refers generally, although not specifically, to publicly funded K-12 school programs.

Delimitations and Limitations

Delimitations

The study topic considered was delimited to the province of Alberta. Developments which were considered were to have occurred within a

1985-1990 timeframe.

Panel members consisted of individuals within the Edmonton area and while the panel represented a variety of organizations with different interests in education, it was not representative of all stakeholder groups.

Limitations

As one of the criteria for selecting panel members was knowledge of computers, panel members may have had a bias in favour of computers.

Interpretation of the data was limited to a single study monitor.

The findings of the study are presented only as a precursor to planning for consideration by educational policymakers.

Organization of the Dissertation

This study has been organized in the following manner:

Chapter 1 has included an introduction, a statement of the purpose of the study, a discussion of the significance of the study, the definitions used, and an outline of delimitations and limitations.

Chapter 2 presents a review of literature and conceptual framework for the study. The literature review focuses on three areas related to the study: the general impact of technology, the impact of computer technology, and educational change.

Chapter 3 describes the methodological framework which includes a

discussion of forecasting, a definition and history of Delphi including a distinction between Conventional Delphi and Policy Delphi, and, considerations for conducting a Delphi study.

Chapter 4, provides a discussion of initiatives related to educational computing in Alberta and establishes the setting for the study.

Chapter 5 provides a description of the research design and procedures utilized in the study. Research procedures are reported for the pilot study and each of the three rounds of the Delphi study.

Chapter 6 provides an analysis of data. An analysis of findings is reported sequentially for each of the three rounds of the study.

Chapter 7 presents a summary of the study and draws some conclusions based on the research findings.

Chapter 8 discusses implications based on the findings of the study. The chapter also presents considerations for future research.

Chapter 2

REVIEW OF LITERATURE AND CONCEPTUAL FRAMEWORK

This chapter consists of two sections. The first section identifies a number of perspectives from which to view the impact of computer technology. It begins by identifying positions from which technology is commonly viewed and then discusses perspectives on the general impact of computer technology in the following areas: society, individuals, education, and trends and issues related to education. Perspectives related to educational change are also presented. The second section establishes the conceptual framework for the study.

Review of Literature

Man has experienced the impact of technology since the first discovery of crude tools. The impact of computer technology is often compared to developments such as the printing press, the industrial revolution, the automobile, and the television. Thus, computers may be viewed as a single artifact in the overall impact of technology. Burch (1984:1), articulates this perspective when he identifies computers as being only an illustration of the larger problem of dealing with technology: "The specific questions of computer technology and computers in the schools are to one level only an illustrative instance of a more general problem." Burch (ibid.) also comments on the

significance of computers: "From the current array of technological artifacts, however, the computer will prove to be a particularly decisive example." Since computers may be viewed as a subset of the overall impact of technology, general perspectives on the impact of technology are further discussed below.

Perspectives on the Impact of Technology

Common viewpoints on technology can be divided into two broad areas: first, the nature of the relationship of technology with society and second, core value positions from which technology is commonly viewed. Each of these areas are expanded under separate headings.

Technology and Society

An essential question related to technology and society is: Do we control technology or does it control us? There are three common views of this relationship: technology determines social change, society and its values drive technological change, and, technology and society are related by a mutual causality (Porter, 1980:11-25).

The first view, technology causes social change, maintains that society reacts to technology instead of leading it. An often cited advocate of this view is French philosopher, Jacques Ellul, and his concept of "technique". He (1964:6) describes technique as having an autonomous life of its own. For Ellul,

technology no longer serves man, man serves technology. The second view, namely that society and its values drive technological change, espouses that technology is not neutral with regard to social values, rather it is the product of these values. Ayres (1979:258) reflects this view: "In short, technology, is not some kind of mysterious self-energized engine that drives society where society does not want it to go. Quite the contrary, technology merely produces what society wants and will put to use." The third view, that of technology and society being related by "mutual causality" is expressed by Porter (1980:22-23): "All human experiences, basic perceptions, definitions of the good life, expectations for the future, and technological developments are shaped by the social, political, and technological milieu in which they exist."

Numerous writers support the third position of mutual causality. For example, Porter (ibid.:23) suggests that the third viewpoint, despite its inherent complexities, is ". . .the safest point from which to view the technology-society interaction." Gosling (1981:9) takes a similar position: "Technology, then, neither totally determines the pattern of human society, nor is by any means without influence on it. Rather, technology is an ingredient in the mix from which the future is created, not the only one indeed, but an important one." In describing the three different views of the effects of technology on schools Postman (1983:311), ridicules the first two positions, labelling them as technological determinist and technological somnambulist, and concludes: "I believe only that the 'future' will be a consequence of what we do now as a

response to our understanding of the problems we face." He further cites (ibid.) McLuhan's "the future of the future is the present" to illustrate that we do have some degree of control in the interaction that takes place. Gosling (1981:8), further establishes a basis for this position:

> The kind of naive technological determinism which claims that the whole pattern of evolution of human affairs is solely and totally set by technological factors and not to be influenced by human decision, individual or collective, by politics or any kind of social action, is a theory of social change to which, surely, no educated person and above all, no engineer could possibly subscribe. . . . At the same time, only the most cloistered thinker would argue that political process could proceed in disregard of the realities which determine the character of the material world, of which the extent and style of technology deployed is one of the most important.

Technology and Core Value Positions

Sullivan (1983:21-24) provides a useful framework from which to view computer technology when he identifies three core value positions from which technological change can be viewed: the advocacy position, the negative position, and, the critical dialectical position. These three positions are also useful as a framework for classifying other writings.

The first is the advocacy position wherein technological innovation is seen in a positive light. Books such as The Micro Millenium (1979), The Third Wave (1980), and Megatrends (1982), view the impact of computers as primarily positive. Ayres (1979:232-241) describes this position as viewing "technology as a panacea" for many of the problems that plague mankind.

Much of the current writing on computers in education could be placed in this category.

The second position (Sullivan,1983:22), the negative, sees "technological innovation in a negative light." Sullivan refers to the work of Jacques Ellul's The Technological Society and George Grant's Lament for a Nation as having value because they (ibid.:23) "...see progress through technology as having a life of its own which negates human intention." Ayres (1979:241) also observes this position: "Many people believe, deeply, that technology is basically dehumanizing, threatening, immoral, or even absolutely evil."

The third position (Sullivan,1983: 23), the critical-dialectical, is "...two-valenced in its attitude toward technical innovation. In other words, it considers technological innovation as having both positive and negative effects on the cultural transendence that occurs." Porter (1980:11) identifies a list of case studies of technological developments that have had both positive and negative effects, for example: human artificial insemination, oral contraceptives, fluoridation, thalidomide, x-rays, and DDT. This position is often reflected in writers who advocate a more balanced view of technology. Bernstein (1983: 108-109), suggests that technological advances, no matter how glamorous, must be founded on substantial values if they are to be of lasting worth. Burch (1984:13), when reflecting on concerns related to computers in schools, concludes that: ". . . what is demanded of us is nothing

less than a philosophical reflection upon the essence of technology itself, and upon computer technology in particular."

Summary of Perspectives on the Impact of Technology

The impact of computer technology may be viewed as part of the overall impact of technology. There exist varying viewpoints on the relationship between technology and society. A commonly held view is that they are intertwined in complex, mutually causal relationships. Technology is also viewed as having potentially positive, negative, and/or neutral effects on individuals and society. We have some degree of control on the way technology affects our lives and it is worthwhile reflecting on the nature and direction of any technological development. The following section discusses the impact of computer technology.

The Impact of Computer Technology

The impact of computer technology has been widely recognized. Society, individuals, and education are often viewed as being profoundly influenced. Aspects of this influence are discussed below under the following headings: society, individual, education, and trends and issues in education.

Society

Computer technology is often viewed as fuelling a transformation from an

industrial society to an information society. While reference to this 'transformation' has become commonplace, a respected work in the area is that by Japanese author Yoneji Masuda, The Information Society as Post Industrial Sociey (1980). In addition to discussing the Japanese plan for transformation to an information society Masuda makes a strong case that the greatest contribution of current technology will be in the area of increasing mental productivity. Other recent works such as the Micro Millenium (1979), The Third Wave (1980), Megatrends (1982), and The Kingdom of Sand (1981), also view computers as contributing to a new society wherein the handling of information plays a critical role. Botkin, in his book Global Stakes: The Future of High Technology in America (1984), predicts a world economy based on knowledge and advanced technology. He suggests that America will be left behind in the technology race unless it develops policies that are clearly committed to technology, one of those policies being (ibid.:158) "a clear commitment to develop human resources upon which economic growth and development are dependent." Similarly, Canadian writers Cohen and Shannon (1984:29), in their work The Next Canadian Economy, recognize the important role of information in our society and describe it as "the currency of the new age."

Henchey (1982:12) refers to the post-industrial society and identifies some key implications for education: "In the industrial society, we had to learn in order to work; it was a working society. In the post-industrial society, we have to learn in order to learn; it is a learning society."

Individual

Accompanying societal changes, computer technology has also recently been viewed as bringing about changes in the individual, particulary in areas related to the mind. Turkle (1984:13) emphasizes the magnitude of this impact: "Technology catalyzes changes not only in what we do but in how we think. . . . It challenges our notions not only of time and distance, but of mind." Papert (1980:26) reinforces Turkle's observation: ". . . I too see the computer presence as a potent influence on the human mind. I am very much aware of the holding power of an interactive computer and of how taking the computer as a model can influence the way we think about ourselves." Turkle (1984:13) suggests that recent developments in technology require more in-depth analysis than just mere explanation of the computer's capabilities:

> I believe that what fascinates me is the unstated question that lies behind much of our preoccupation with the computer's capabilities. That question is not what will the computer be like in the future, but instead, what will we be like? What kind of people are we becoming?

Turkle (ibid.:246-247) later suggests that computer related developments such as artificial intelligence have the potential to restructure how we think about ourselves and thereby have an impact analogous to the work of Freud or Marx:

> . . .artificial intelligence is making a big claim, announcing itself, as psychoanalysis and Marxism had done, as a new way of understanding almost everything. In each case a central concept

> restructures understanding on a large scale: for the Freudian, the unconscious; for the Marxist, the relationship of the means of production. . . .for the AI (artificial intelligence) researcher, the idea of program has a transcendent value: it is taken as the key, the until now missing term, for unlocking intellectual mysteries.

Torok (1984:229) identifies a phenomenon similar to the one which interests Turkle and classifies it as peopleware:

> Digital computers were seen as tools for managing information, thus a large number of non-computer-literate workers were drawn into the human-machine interface. . . .peopleware refers to the psychological impact of technology on users.

Bolter (1984) identifies a similar impact, albeit from a somewhat different perspective. He (ibid.:4) also observes ". . . a change in the way men and women in the electronic age think about themselves and the world around them." Bolter (ibid.:41) suggests that ". . .we now have an inanimate metaphor for the human mind as compelling as the clock was for the planets." He (ibid.:219) describes those who accept his view as "Turing's Men," after logician-mathematician A. M. Turing, and also outlines the change in the way which people think about themselves: "But Turing's man is so caught up in the computer metaphor that he refuses to wait for the genetic solution; he chooses to regard man as software more than hardware, as the program run by the computer more than the hard-wired machine itself." Use of this metaphor is not uncommon in education circles, a striking example was provided by David King, Minister of Alberta Education. King (1984) suggested that the present concept of teachers is based on an industrial model wherein the teacher is

viewed as an "organic data base."

Education

Computer technology has fueled numerous developments in education. Major developments are discussed under the sub-headings of acquisition, usage, and potential applications.

Acquisition. In terms of the number of computers acquired by schools it is evident that, within a very short time-frame, they have made a significant impact on schools. The proliferation of these machines is evidenced throughout North America. Within Alberta, the Minister's Task Force Report (June, 1983) cited several studies that indicated a dramatic increase in the number of computers in schools. It also projected that this increase would continue. Recent grants will ensure that this increase continues until at least 1986. Similarly, Weiner (1984:36) reports initiatives in Ontario and Quebec that would also indicate continued rapid growth of computers in the classrooms of those provinces. Within the U.S., Bork (Dec. 1984:240) estimates that over the past few years ". . . the number of computers in the schools has roughly doubled each year." Bork also observed that this growth has occurred despite poor funding arrangements and inadequate software. Morgan (1984:1) cites studies by the National Center for Educational Statistics, Educational Research Service, and the U.S. Office of Technology Assessment which attest ". . . to sharp growth of

educational technology, especially microcomputers, in the past few years."

The rapid growth in the number of computers in schools is largely the result of enthusiasm for this technology. The Minister's Task Force (1983:19) reported that on the basis of planning and progress underway, within all the provinces, that ". . . educators are enthusiastic about educational computing." Members of the Task Force also visited the U.S. states of Minnesota, Texas, and California, and reported a high degree of commitment as well as a variety of activities and level of integration.

While actual applications and approaches vary, Senese (1983:iv) reminds us that ". . .surveys of computers in schools are outdated by the time they are published", it is useful to review some recent surveys and studies in order to gain a clearer perspective on recent applications of computers in schools. The following sub-section outlines reported findings on the major applications of computers in schools.

Usage. As early as 1980 a significant portion of American students had access to computers. Baker (1982:20-21) reported on a U.S. study done in 1980 which found that of 15,834 school districts surveyed, 48% provided students with access to computers. The survey (ibid.:21) also reported that in terms of computer use:

> . . . developing computer literacy was the most frequently mentioned goal. Other frequently mentioned uses were learning enrichment in specific subject areas and challenges for high achievers. Remedial

and compensatory applications were listed by fewer than half of the responding districts.

Similarly, in a more recent Ohio survey of school districts throughout the state Morgan (1984) grouped the instructional use of computers into three categories: computer assisted instruction (CAI), computer managed instruction (CMI), and computer based learning (CBL). The study also made a distinction between microcomputers and mainframes. It included in the microcomputer category the following machines: Apple, Radio Shack, Texas Instruments, Commodore/Pet, Atari, Timex/Sinclair, and I.B.M. Mainframes (ibid.:4) were described as having "larger memory and faster processing capabilities" than micros. The reported rate of usage for mainframes and microcomputers in each of the three categories is included below.

Computer Assisted Instruction (CAI). Across school district types, mainframes were used for less than 6% of the total applications. Microcomputers were used for:

Drill and Practice	69%
Remediation	61%
Tutorial	52%

Computer Managed Instruction (CMI). Across school district types, a nearly

equivalent use of micros and mainframes were used for:

	Mainframe	Micro
Student Testing	10.0%	12.1%
Generation of Student Reports	16.1%	14.5%
Development of Instructional Prescriptions	4.5%	8.5%

Computer Based Learning (CBL). Across school district types, mainframes were used for less than 6% of the total applications. Microcomputers were used for:

Computer Literacy	82.2%
Computer Programming	78.2%
Word Processing	38.1%
Simulation	38.4%
Problem Solving	58.6%

An important feature of the Morgan study (ibid.:1) was that it reviewed other state and national studies related to educational technology and reported that, at the school level: ". . . most were at about the same stage as Ohio-surveying their school districts and preparing reports of the results."

A study on the patterns of microcomputer use within the classroom was

conducted by Shavelson, Winkler, Stasz, Feibel, Robyn and Sheha (1984). The study (ibid.:iii) had as one of its prime objectives: "To describe how teachers who were nominated by their peers as 'successful' microcomputer-using teachers use the technology for instruction." Despite the fact that the study was conducted in California, a state reported (ibid.:5) to be ". . .representative of microcomputer use in other leading states," one of the major conclusions (ibid.:30) was that: ". . . microcomputer-based instruction by teachers dubbed 'successful' by their peers, other educators, and administrators is not monolithic." Not only did Shavelson et al. (ibid.:29) find little microcomputer-based instruction occurring in the classroom, they reported experiencing difficulty in locating teachers who were using microcomputers successfully.

Similarly, Bork (1984:242), when commenting on the classroom situation stated that:

> Despite the growing presence of computers in U.S. schools and colleges, computer-based learning remains a very small fraction of the total instructional system. . . . In fact, I would be surprised to discover that the computer occupies more than 1% of the total time devoted to instruction in the U.S.

A study by Sheingold, Kane, and Endreweit (1983) supports the observation that computer technology has a limited impact on school systems. The study (ibid.:428) on how different school systems used microcomputers found that in none of the sites studied:

> . . . were microcomputers intended to change or replace existing curriculum; rather, they were to be additions. Either computers complemented classroom activities, or they comprised an additional curriculum in and of themselves (for example, computer literacy and computer programming).

The authors concluded (ibid.:431): "This study more strikingly illustrates the assimilation of technology by school systems than the impact of technology on them." Becker (1984:28-29) reinforces this observation when he cites 1983 studies done by the Center for Social Organization of Schools:

> Schools today use computers primarily as an object of instruction--to provide students with cursory computer literacy exposure and to teach a minority of high school students to program microcomputers in the general computer language called BASIC. Apart from these uses, though, by far the most common way that schools use their computers is with commercial and locally produced programs that give students math and language-arts skill-building drills and that test their knowledge of social studies and science facts.

Becker (ibid.:29) also commented on the many drill-and-practice applications identified and noted that they differ ". . .substantially from the infinitely patient and directly instructive tutor imagined in our dreams about computer-assisted instruction (CAI)." Sheingold et al. (ibid.:431), in commenting on the limited existing applications of computers, further concluded that microcomputers alone will not promote any particular outcomes and that the results of their study "suggest that the effects of microcomputers on education will depend, to a large extent, on the social and educational contexts within which they are embedded."

The observations described above support earlier concerns identified by

Seymour Papert and Joseph Weizenbaum. Papert (1979:74) provided examples of three ways the use of computers in education can be classified: drill and practice, simulations, and learning simple programming languages. He then proceeded to ". . . stress the underlying sameness of these forms or computer use." He (ibid.:74) further stressed that these practices, in fact negate exploiting the full potential of the computer through reinforcing traditional models of education: "What they have in common is that they share 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." Papert (ibid.:74-75) used drill and practice as an example to question the notion of helping a student to catch up without asking the hard questions ". . . about why he had to get caught up and what it is he is catching up to." Weizenbaum (1979:440), when discussing computers in education, suggests that schools are very resistant to change and that very little change is possible without first addressing the institutional nature of schools:

> No fix, technological or otherwise, of the American education system that does not recognize that American schools are rapidly becoming America's principal juvenile minimum security prisons can be expected to have socially therapeutic effects. Giving children computers to play with, while not necessarily bad in itself, cannot touch this or any other real problem.

Potential Applications. There exists a good deal of optimism regarding the potential applications of computers in education. Senese et al. (1983:v), in acknowledging the limited existing applications described above reflect much

of this optimism: "Although most currently available applications for schools are mediocre, the possibilities for significant uses are impressive." They (ibid.:3-4) describe a list of opportunities in the following areas: tutoring, simulated learning environments (simulations), diagnosis, networks, tools for students and teachers (allowing for more emphasis on sophisticated thinking skills rather than routine tasks), game technologies, and, administrative tasks. Williams (1984:27) describes computers as providing increased opportunities for the handicapped, particularly the blind, visually impaired and speech impaired. Stephen Jobs (1985), speaking at a recent conference, made two major points related to the potential of educational computing. The first was that future developments in storage capacity will allow enhanced simulated interactive learning experiences such as creating a molecule: ". . . that you can zoom into, and see flying around you, to play with this molecule, inside." The second point was that networks, in increasing communication among individuals, will enhance the capability of computers ". . . so all of a sudden you aren't interacting with a computer anymore, you're interacting with another human being." Jobs (ibid.) concluded by sharing his dream:

> My dream is that if you look at computers as the carriers of underlying principles that can facilitate thousands of individual learning experiences, what we've got here is a miraculous tool that gets better and better each year. . . .someday with the next Aristotles living among us, we can over time, somehow capture Aristotle's world view. . . . you could actually ask the next Aristotle a question, and get an answer. And it might not be the exact one that the real Aristotle would have given, but it's a lot better than what we have now.

Kohl (Ebisch,1984:38) offers two versions 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. Worse, teachers could just chain the kids to machines. The teacher would have his own machine with an electronic spreadsheet that'll control all the others and they'll be locked into a very uninventive system that we already know is not doing very well. . . . The other possibility is that the computer becomes a tool to extend the capacities 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.

Kohl (ibid.) expresses the concern that while he would like to see the second possibility occur he fears that ". . . without some deep human and moral change and real understanding of how people learn and how computers function. . . " the first possibility might become the most "prevalent" one.

On another level, there are those who suggest that developments in information storage, transfer, and retrieval will challenge the whole notion of schools as they presently exist. Much learning will be able to take place at home in what is often described as an "electronic cottage" (Toffler, 1980; Deken, 1983). Uhlig (1983:4) identifies a possible role of the school in such an environment: "The home may again, as it was 300 years ago, become the true center of learning for many students. Schools may be more well suited for recreation, socialization, dramatic and fine arts, and athletics." Papert (1980:9) speaks of similar developments, however, he is much more critical of existing

schools and the need for reform:

> I believe that the computer presence will enable us to so modify the learning environment outside the classrooms that much if not all the schools presently try to teach with such pain and expense and such limited success will be learned, as the child learns to talk, painlessly, successfully and without organized instruction.

In stressing the need for reform, he (ibid.) also identifies the consequences of not meeting the challenge: "This obviously implies that schools as we know them today will have no place in the future. But it is an open question whether they will adapt by transforming themselves into something new or wither away and be replaced."

Trends and Issues in Education

Previous sections of this chapter presented the computer as one of the more significant technological artifacts of our time and outlined some of the potential effects on society, individuals, and education. The impact of this technology has generated a number of trends and issues in education. These trends and issues are discussed under the headings of curriculum, teacher training, courseware, hardware, access/equity, planning/organization/funding, changing roles, and, effects and outcomes. Burch (1984:4) categorizes many of these trends and issues when he speculates that many of them are related to basic pedagogical questions: ". . .the issues surrounding the use of computers in the schools will confront us less with a uniquely new set of problems special

to the use of this new artifact, than with the occasion and impetus to re-ask basic and perennial pedagogical questions."

Curriculum. The impact of computers on matters related to curriculum is often identified as an area of great concern (Rockman, 1983; Sheingold et al., 1983; Minister's Task Force, 1983; A Nation at Risk: The Imperative of Educational Reform, 1983). Gress (1981:42) articulates a common theme of much writing on computers and curriculum: "The present and future technology of the computer mandates that the curriculum be reformed." While there may be need of reform, Sheingold et al. (1983:428) observe: "The relationship of the microcomputer to the classroom is one of the most complex issues." As noted in the preceding introduction to trends and issues in education, much of the issue is related to re-asking some of the "perennial pedagogical questions" in a curricular context. Essentially, matters related to curriculum deal with the organization and dissemination of knowledge or as Burch (1984:18) states in his general definition: ". . . by curriculum I mean a decision about what is most worthy of being learned, and a pedagogical strategy for creating the conditions in which such learning can best take place." The decisions, as Henchey (1982:12-13) observes, reflect the environment: "Curriculum does not have an independent existence. . . .each era must rethink and reshape its conception of the educated person within the framework of its own assumptions, needs, and priorities." The rapidly changing situation, brought about largely by the advent

of computer technology, has precipitated basic curriculuar questions in areas such as situation analysis, selection of objectives, selection and organization of content and methods, as well as evaluation. Each of these areas is discussed further.

The Minister's Task Force (1983:42) observed that as the changing nature of society would require a new set of skills that schools be required ". . . to offer instruction in new skills and to facilitate the acquisition of knowledge that will be required in the future." Similarly, Burch (1984:5) in arguing that the computer is the "most important technological instrument of our time" observes: "If we are going to be able to function at all competently in the new situation, we shall all have to learn to use a computer and, one hopes, to use it wisely." Few can argue that computer technology is contributing to a change in society and occupational patterns. Works such as The Third Wave (1980), Megatrends (1982), and Global Stakes (1982), have done a great deal to create an awareness regarding the situation. A major curricular challenge is to monitor and respond to the changing situation with regard to society, technology, students, teachers, and resources.

Setting proper objectives presents a further curricular challenge. What should students be learning? The rapid and ever increasing changes in technology, particulary communications and computers, make this a particularly difficult question. Henchey (1982:13) succintly illustrates the difficulty of the problem with the simple question: "What should constitute the educated person

of the year 2000?"

How do we select and organize curriculum content that adequately meets our objectives and reflects the changing situation? Henchey (1982:13), when speaking of the implications of new communications technologies, addresses these concerns with the following questions:

> What skills are so important for learning how to learn and how to live a full life that no young person should be without them? What knowledge is of such worth that no young person can truly understand his world and himself and establish her sense of meaning without it? What values are so central to our social project that no young person can find inspiration without them?

Papert (1980:140) argues for a departure from existing practice: ". . .we should be prepared to undertake far-reaching reconceptualizations of classical domains of knowledge."

A further issue is what methods should be used to present the content selected? Sheingold et al. (1983:429) provide a context for this issue:

> How the microcomputer can effectively be integrated with classroom curriculum is currently one of the pressing issues of computer use in education. It seems likely however, that the process of integration will also be one of change. The task is not merely to put two matching pieces--a curriculum and a computer--together. Rather, it is to actively mold the pieces so that they complement each other.

The issue raises a number of questions. Rockman (1983:14) expands on it when he questions the extent of the integration of microcomputers:

> Computer literacy, CAI, programming, and access to data bases are common applications. What are the best uses for computers in classroom curriculum? At what grade level should the computer be

introduced? In which content areas can it meet curricular goals and student needs most effectively?

Closely related to the area of methods (as well as content) is whether curriculum should be standardized or innovative (Peterson, 1984:14-15). A standardized curriculum, while having implementation advantages in the area of consistency and conformity, does very little to encourage new ideas and innovation. Conversely, a curriculum that is more flexible and innovative, while encouraging the development of new applications and methods, also carries all of the risks inherent with prototyping any new activity--mistakes are inevitable.

Most of the material discussed above also presents challenges in the area of evaluation. Perhaps the biggest challenge for evaluation is addressing questions (Nicholls and Nicholls:1972) fundamental to curriculum: Questions related to why we study are just as important as what we study.

Teacher Training. Hunter (1984:16) observes that, in relation to teacher training: ". . . every professional journal, and even the popular press tells us, we must become computer literate to cope with the forthcoming revolution in education." Related literature on teacher education can be divided into two broad areas: preservice and inservice. Friedman (1983:16) alludes to both areas when he suggests that: "Above all, let us teach our prospective and continuing teachers to incorporate educational computing in teaching." The Minister's Task Force (1983:45) in identifying teacher reception as being critical

"to the sucess or failure of any innovation in education" further divided the issue into four categories: preservice, graduate programs, inservice, and continuing education. Essentially, the report recommeded increased opportunities for teachers to receive instruction in all of the categories. Different levels of knowledge and interest in computers makes the preparation of teachers a particularly difficult task (Uhlig, 1983:3; Sheingold et al., 1983:429). Fundamental to the issue (ibid.) is the question: "What kinds of knowledge and experience do teachers require in order to use computers effectively in their classrooms?"

Uhlig (1983) stresses two important points regarding the process of achieving an ongoing computer literacy for teachers. First he stresses (ibid.:2) that: "Technological literacy, unlike some other kinds of literacies, is not an event; it is a continuous process." He further suggests that because the process is continuous, strategies to deal with it must be ongoing. Secondly, he (ibid.:4) notes that: "Some districts and some teacher training institutions will make early mistakes in addressing the problems and potential of the new technologies." He argues that while mistakes are inevitable we must learn to live with them.

Courseware. The terms courseware and software are often used interchangeably (Minister's Task Force, 1983:57). Software is the program that is actually run on a computer; courseware is a broader term encompassing the

total collection of learning materials, part of which is software.

Central to the issue of courseware are two words: quantity and quality. A significant quantity of courseware is being produced for education, however it is of limited quality (Bork, 1984:240; Minister's Task Force, 1983:57-58; Sheingold et al., 1983:429). Komoski (1984:247), citing the findings of a national evaluation by the Education Products Information Exchange (EPIE), observed that of the many software programs available: ". . . only 5% of these hundreds of programs have been judged to be of truly high quality, while more than half have been judged not worth recommending to educators or parents." Alberta Education's Clearinghouse reports a similar rejection rate. A recent Kappan feature (May, 1985:659), reported that: "Of more than 5,000 programs analyzed by 16 leading U.S. and Canadian evaluation services, only 13 were deemed excellent." Largely due to the lack of suitable courseware available, the Minister's Task Force (1983:58) identified the promotion of high-quality courseware as an area of concern. Becker (1984:30) while commenting on the lack of appropriate software, cites a reason for the abundance of drill-and-practice programs presently being used in schools: "They have obtained equipment and then tried to find appropriate ways to use it with their students. . . . schools use drill and practice programs because they are there, and they are there because producers can produce them and because producers believe schools are likely to buy them." Also related to the issue of courseware is the unauthorized duplication of materials (Rockman, 1983:14).

Hardware. A simple extrapolation of past trends tends to indicate that computing hardware will become better, cheaper, faster. These developments are complicated by the fact that the computing business is highly competitive and unpredictable (even major companies such as IBM have done extensive marketing of a computer only to cease manufacturing a short time later). A basic dilemma faced by educators is selecting the proper equipment. Central to the issue of hardware selection is establishing standards related to the acquisition of equipment and the dilemma of choosing between variety versus compatibility (Peterson, 1984:15). Do educational agencies settle on a specific set of equipment and realize benefits associated with volume buying, compatibility, training, and maintenance? (These benefits accrue to not only computers but transfer to other areas such as software, peripherals, and networks.) Or, in realizing the benefits associated with standardization do they accept the drawback of binding (ibid.) ". . .all future computer uses to the capabilities of that particular manufacturer and its equipment, thus eliminating the possibility of benefiting from changing technology in an industry where change is the most predictable event." A second drawback of using only one brand of computer is that "no single brand is best for all applications" (Minister's Task Force, 1983:72) and some brands, for example, would be overpriced for simple applications (ibid.; Peterson, 1984:15).

Access/Equity. Aspects of the access/equity issue could also be discussed under the headings of curriculum and hardware, however, the issue has sufficient scope to merit a separate heading. Two major dimensions of the issue are actual physical access to the machines and applications to which students are exposed. Each of these dimensions are discussed further below.

Sheingold et al. (1983:426), in their study of three separate school systems, reported that largely due to funding: ". . .there was differential access to microcomputers at both the elementary and secondary level." Citing a study done by the National Center for Education Statistics (1982) they (ibid.) reported: "inequities of microcomputers nationwide, based on the economic level of school systems." Similarly, Uhlig (1983:4) reported a study done by Market Data Retrieval in 1982 which showed ". . . microcomputer availability in the schools directly related to the wealth of the district being served." Sheingold et al. (1983:427) offer a further underlying reason for this occurence: "A local initiatives model of innovation could unintentionally result in differential access." Peterson (1984:11) while acknowledging that "local control of education provides choice and encourages experimentation" suggests that there is a need for overall policies regarding access "If computers and computing do make a difference in education. . . ."

Peterson (1984:11-12) provides a discussion of two issues related to educational computing and access at the school level. First, in a discussion on "egalitarianism versus critical mass" he notes that while there are advantages

to equal distribution within schools (primarily because it is fair and simple), there are also disadvantages in that some machines will be underutilized and there will never be the "critical mass" necessary for ideas and creativity to "take off." Second, he (ibid.:12) describes the advantages and disadvantages of the "computer lab versus the computerized classroom." Placing computers in a lab has the advantage of a "sense of fairness of equal dispersion while at the same time it incorporates some of the advantages of critical-mass concentration." There are also disadvantages (ibid.), first, if the lab has an optional component it tends to "attract mainly boys", and second, computers become isolated from the curriculum: "The labs separation from the classroom more or less defines how the school regards computing--as something separate and apart."

Sheingold et al. (1983:427) concede that with ever increasing numbers of microcomputers many of the problems associated with access will be overcome but also warn of another danger when they suggest that equality of access does not insure equality of opportunity: ". . .current trends could contribute to a future in which levels of achievement determine what students are permitted to do with computers. Less able students will use computers for drill and practice, while the more able will learn to program." Similarly, Shavelson et al. (1984:31), concluded in what they referred to as "potentially startling" findings:

> Paramount is the finding that students in classrooms characterized as low in ability and high in percentage minority received computer-based instruction primarily from drill-and-practice programs, while students in classrooms characterized as high in ability and low in percentage minority received instruction from a myriad of computer programs,

> including drill and practice, tutorials, simulations, microworlds, and games. If the medium is the message, the message delivered to students in the former classrooms is substantially different from the message received by students in the latter.

If we are able to rationalize that some identifiable groups need computers there are other implications that need to be considered. Peterson (1984:12) suggests that: "In any case we're still talking about discrimination: giving expensive resources to a few." Sheingold et al. (1983:426) make two observations regarding the issue. First (ibid.), they note that, at the elementary level, there may be long term implications such as a "stigma" attached to using computers primarily in areas such as remediation. Second (ibid.), they suggest that at the secondary level "If anybody is being excluded from computer use, it may be the average student."

In a California study of "skills, knowledge, attitudes and experiences" of sixth and twelfth grade students in the area of computer technology Fetler (1984:ii) reported that: "Boys reported having more experience with computers, and this experience was associated with higher test scores, than girls." This finding is partially explained by general enrollment trends in computer related courses which (ibid.:2): "follow those traditionally found in science and mathematics, girls are not benefiting from such instruction as much as boys." In addition to concluding that sex equity is one of the issues "faced by schools in defining a policy for the use of computers," Fetler (ibid.:22-23) questioned the role of schools: "Is it proper for public schools to provide students with entry

level skills for use in obtaining jobs?" A further observation made by Fetler (ibid.:20) was that social class, which ". . . historically, has been correlated with achievement of all kinds. . . .is clearly demonstrated in the area of computer studies. . . ."

Planning/Organization/Funding. The Minister's Task Force (1983) further cited planning, organization, and funding as important issues. The report (ibid.:82) in recognizing that we are ". . . entering a new field of endeavour in education" stressed the need for widespread participation in clearly defined structured plans that would be regularly monitored. Leadership, at all levels, was identified as crucial to the planning process. The report (ibid.:86) also emphasized the need for organizational structures, particularly at the provincial level, which would be "durable enough to be stable and reliable, yet flexible enough to adapt to change." These organizational structures were viewed (ibid.) as being important for coping with the major enduring issues of educational computing. The Task Force (ibid.:92) stressed the importance of funding for realizing the potential of computing: "Educational computing requires a significant financial investment." Becker (1984:30), when commenting on the over abundance of drill and practice programs, also stressed the need for systematic planning: "Another reason that schools use drill-and-practice programs is that many schools have begun their involvement with computers without a systematic plan for how computers might improve the

educational enterprise."

Changing Roles. In addition to changing roles within the actual instructional process there exists concern regarding new and changing roles in other areas. The roles of teachers, students, and administrators, are reflected in these concerns.

Sheingold et al. (1983:427) identified two new roles as those of the "teacher buff" and "student expert." Teacher buffs often end up outside of teaching: ". . . the computer enthusiasts we observed were employed by the instructional design groups or the central administration and were no longer teaching." Shavelson et al. (1984:29) also observed this phenomenon and identified it as the "vanishing computer-using teacher" where: "Teachers nominated as successful in educational applications of microcomputers disappeared from their classes to become 'computer coordinators' in their districts or software developers in the burgeoning information technology industry." Sheingold et al. (1983:427) suggest an additional migration path for these individuals: "The individuals in these roles may burn out or leave the system for more lucrative positions in industry." Sheingold et al. and Shavelson et al. advocate the need for policies to retain those individuals who are making a positive contribution to education. The emerging role of student experts was also identified by Sheingold et al. (ibid.:428) as changing the student-teacher relationship: "Student experts established new relationships

with teachers. . . :" They (ibid.) also reported that these student experts are likely to "increase in number," make new "demands on school systems," and "seek learning opportunities outside of the structure of formal education" if schools are unable to meet their demands.

Computers have a wide variety of applications in administration. Tymo (1983:33) provided a taxonomy of 107 school administration functions for which there were computer applications within the three broad areas of information management, communication, and planning. Administrators appear to rely increasingly on computers to perform adminstrative tasks.

Effects, Outcomes and Research. Sheingold et al. (1983:430) contend that "No one yet really knows the educational or developmental consequences of using microcomputers." They (ibid.:431) also further suggest that in relation to the educational outcomes of using microcomputers: "We need to begin acquiring such knowledge very quickly in order to help guide an innovation which is growing rapidly." On a broader level, Uhlig (1983:4), in noting that every age has experienced negative side effects of technology, asks: "What will be the negative side effects of an information-based society?" He (ibid.) suggests that we will have to address problems in the areas of ". . .privacy, security, and socialization needs of youth." Peterson (1984:14) suggests we need to ask questions along a similar theme in terms of identifying: "What's a computer good for?" According to Peterson (ibid.:18) basic questions which

need to be asked are: "Is it worth it?. . .How much of the educational computer movement is based on solid ground and how much of it grows out of shared expectations that have no basis in fact?" He (ibid.) also provides a rationale for asking these questions:

> Given the massive outlay of funds for educational computing, these are questions that need to be answered soon. Or if not answered, at least confronted. Teachers and administrators, parents and school boards, all need something to go on to make decisions they have to make about goals and curriculum. And if no one else does it, the taxpaying public may soon demand an accounting.

The Minister's Task Force (1983:98) also stressed the importance of research related to the issues surrounding eductional computing, identifying the following areas as being important: ". . .the effects of computing on the learning process, the role of teachers, and the organizational structure of schools, the mental and physical effects of computer use on students, and the implications of computers to social attitudes and relationships." Becker (1984:32) observes that as we know very little about what constitutes good teaching ". . .our ability to create computerized interactive intellectual environments is limited." For Becker (ibid.) this provides a rich environment for future research: "The scholarly and programming effort required to improve tutoring abilities of computers could involve lifelong careers in and of themselves."

Summary

Computer technology is often viewed as having a significant impact on

society, individuals, and education. Accompanying this impact are a number of trends and issues in education. There also exists a need for research in a variety of areas. It is evident that educational organizations have already made a significant commitment to computer technology. As this commitment portends future change in education, the following sub-section reviews aspects of the literature related to educational change.

Educational Change

Much of the preceding literature on computer technology and education relates to the process of educational change. Realizing the pedagogical promise of this technology requires many changes in the educational enterprise. This sub-section presents perspectives on the change process as well as recommendations and observations regarding change.

Perspectives on the Change Process

When speaking of educational change, it is erroneous to assume that because a techno - is available it will automatically be adopted. Sheingold et al. (1983:413) concluded that merely putting computers in classrooms is likely to have little positive effect: "Putting a machine, albeit a powerful and engaging one, into a classroom is unlikely to have a positive effect on children and teachers." Numerous other writers (Papert, 1979; Weizenbaum, 1979; Shavelson et al., 1984; Bork, 1984) support this conclusion in expressing

concern that despite an increase in numbers, computers have had little meaningful impact on instruction within the classroom. This concern, namely that meaningful educational change does not occur easily, is supported in the literature on change (Charters and Pellegrin, 1972; Berman, 1980). However, as evidenced by recent efforts at computer acquisition, most educational organizations have already made a commitment to change. This commitment appears to have both short term and long term implications for change, as Grant (1965:72) observed: "When men are committed to technology, they are also committed to continual change in institutions and customs." As mechanisms related to the change process appear to play a pivotal role in the adoption of computers by educational organizations, and the process appears to be crucial to realizing the potential of computers, major perspectives related to change are further described.

While change is possible, it is often a long, slow, process. House (1974:5) observed that: "Education is a frozen institution." He (ibid.) also provided an interesting analogy when suggesting that education, like the sea shore can be changed, "but only from countless social winds and waters." Peddiwell reinforced the concept of education being resistant to change in his often quoted Saber-Tooth Curriculum (1939) where he parodies curriculum practice as preserving the status quo and supporting subjects that have outlived much of their usefulness. Similarly, Papert (1980:33-34) used the example of the standard QWERTY typing keyboard to illustrate that we have a

tendency to preserve ". . .practices that have no rational basis beyond their historical roots." Marris (1974), speaking from a sociological perspective, presents resistance to change as a natural, human reaction which is an inevitable part of life.

Naisbitt's three stages of technological development are often cited in reference to technological change and the impact of the computer. He (1982:27) outlines these stages as occurring sequentially:

> First, the new technology or innovation follows the line of least resistance; second, the technology is used to improve previous technologies (this stage can last a long time); and third, new directions or uses are discovered that grow out of the technology itself.

Michael Fullan has synthesized much of the literature related to change. He (1982:13) observed that there "will always be pressures for educational change" and cites Levin (1976) when identifying both external and internal sources of educational change:

> . . .there are three broad ways in which pressures for educational policy change may arise: (1) through natural disasters such as earthquakes, floods, famines, etc.; (2) through external forces such as imported technology and values, and immigration; and (3) through internal contradictions, such as when indigenous changes in technology lead to new social patterns and needs, or when one or more groups in a society perceive a discrepancy between educational values and outcomes affecting themselves or other in whom they have an interest.

Fullan (1985:392) cites Hall and Loucks (1977) to make another principal observation regarding change. "The simple but powerful phrase 'change is a

process, not an event' connotes that something is happening over a period of time to transform individuals and situations." For Fullan (ibid.:391), initiating change is a complex, multi-dimensional, dynamic phenomenon:

> . . .we know that deliberately attempting change is a complex, dilemma-ridden, technical, sociopolitical process. Looked at one day, in one setting, successful educational change seems so sensible and straightforward; on another day, in another situation, improvement cannot be obtained with the most sophisticated efforts. Change is at once simple and complex, and therein lies its fascinatation.

Numerous studies of educational change have revealed a number of insights related to the process. The following section describes recommendations regarding attempts at change.

Recommendations and Observations Regarding Change

Fullan (1982:297) believes that meaningful educational change is possible and suggests that ". . .we can no longer hide behind the excuse that worthwhile change in practice through deliberate means is impossible." Successful change, according to Fullan (ibid.:295), must have "individual meaning" for all involved: ". . . not just the teacher, but the principal, the consultant, the student, the government official." He (ibid.) suggests every change has two components and that all problems related to change can be compressed into aspects of these two components:

> Every change has two components: an implicit or explicit theory of education (what the change is) and an implicit or explicit theory of change (the process being followed to implement it). Individuals must

> find meaning in both aspects: What does the change mean for what I do? What does the process of introduction and follow-through look like from my perspective? All of the problems of change can be compressed into these two aspects.

For Fullan (ibid.) the key to school improvement is ". . . to recognize that individual meaning is the central issue, and to do things that will enhance that meaning." He (ibid.:13) also suggests that we should always ask two critical questions: ". . .who benefits from the change (the values question), and how sound or feasible is the idea and approach (the capacity for implementation question)?"

Studies of actual change projects also provide much useful information related to change. In regard to large scale change projects Berman and McLaughlin (1976:347) established the following premises regarding the innovative process:

1. Implementation--rather than the adoption of a technology, the availability of information about it, or the level of funds committed to it--dominates the innovative process and its outcomes.
2. Effective implementation depends on the receptivity of the institutional setting to change.
3. Effective implementation is characterized by the process of mutual adaptation.
4. Local school systems vary in their capacity to deal with innovations and with the stages of the innovation process.

They (ibid.) also discussed the policy implications of these premises:

1. Policy should be concerned with more than the mere adoption of change agent projects. . . .
2. The critical significance of the institutional setting should

come as no surprise to policymakers. . . .

3. If given a receptive institutional setting, a project's outcomes depend critically on local decisions about how the project will be implemented, federal policymakers might consider ways of encouraging mutual adaptation strategies which we believe are the key to effective implementation.

Charters and Pellegrin (1972:11-12), studied problems related to organizational change at the school level and identified a number of themes related to the implementation of major educational change:

1. The fundamental but generally unacknowledged strain that exists between the ideology of teacher governance and the strategy of directed change.
2. The gross unclarity in conceptualization and definition of what the schools are attempting to implement through change projects.
3. The heavy reliance on structural change (writing job descriptions, changing titles, altering organizational units) in belief that appropriate behaviour changes will automatically follow.
4. The fallacious assumption that a statement of general, abstract program values and objectives will easily be translated into new and appropriate behavior patterns at work.
5. The unrealistic time perspective of those responsible for educational innovation, according to which basic and far-reaching changes in instructional roles and staff relationships are seen as accomplishable within a year or two.
6. The ambiguities and stresses that arise in the disjunction between the school district's established administrative structure and the temporary system for project management.
7. The failure to recognize that teachers have scant training and experience in forming and implementing processes and procedures for collaborative decision making.
8. The conflict in goals, values, and interests, seen especially in the relationships between the central office administrators, the project managers, and the school staffs (produced mainly by the requirements of their inherently different work contexts).

9. The absence of managerial and monitoring procedures to assure implementation and to alter plans in the face of contingencies that inevitably occur.
10. The failure to recognize the severity of role overload among members of the instructional staff when innovation is attempted.
11. The tyranny of the time schedule in constraining change.
12. The apparent assumption that schools need little additional resources (financial and personnel) to cope with the massive organizational disruptions during the period of transition from one educational program form to a new one.

Similarly, Fullan (1985:392) draws on four recent studies of successful change to ". . . illustrate what might be called an emerging theory of change processes within schools." He (ibid.:396) summarizes change at the individual level as ". . . a process whereby individuals alter their ways of thinking and doing (e.g. teaching in this case). It is a process of developing new skills and, above all, meaning and satisfaction in new ways of doing things (see Marris 1975; Fullan 1982)." Fullan (ibid.) makes seven observations based on the four studies of successful change:

1. change takes place over time
2. the initial stages of any significant change always involves anxiety and uncertainty
3. ongoing technical assistance and psychological support assistance are crucial if the anxiety is to be coped with
4. change involves learning new skills through practice and feedback--it is incremental and developmental
5. the most fundamental breakthrough occurs when people can cognitively understand the underlying conception and rationale with respect to "why this new way works better"
6. organizational conditions within the school (peer norms, administrative leadership) and in relation to the school (e.g. external administrative support and technical help) make it more or less likely that the process will succeed.
7. successful change involves pressure, but it is pressure

> through interaction with peers and other technical and administrative leaders.

Finally, Berman and McLaughlin (1976:346) make an observation that may be utilized to characterize many of the efforts at technological change within educational settings when they observe that large scale efforts aimed at change rest on common assumptions:

> They assume more or less explicitly that American education should be doing better with respect to a variety of goals. . . .They also assume that educational practices, procedures, and methods can be improved within the existing educational structure.

Summary

While computer technology may be described as a force for educational change, meaningful educational change does not occur easily. Change is a complex, dilemma-ridden process; certain aspects over which we can exert some control. The following section outlines the conceptual framework for the study.

Conceptual Framework

The preceding review of literature has established that: (1) There are both positive and negative dimensions to the impact of technology--certain aspects over which we can exert some control. (2) The impact of computer technology, while already of significant proportions, portends even more change in the future. There are numerous educational implications for these

changes. (3) While meaningful educational change is possible, it is a complex, dilemma-ridden process.

The conceptual framework for this study was derived from 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 clarifies 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) present 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:

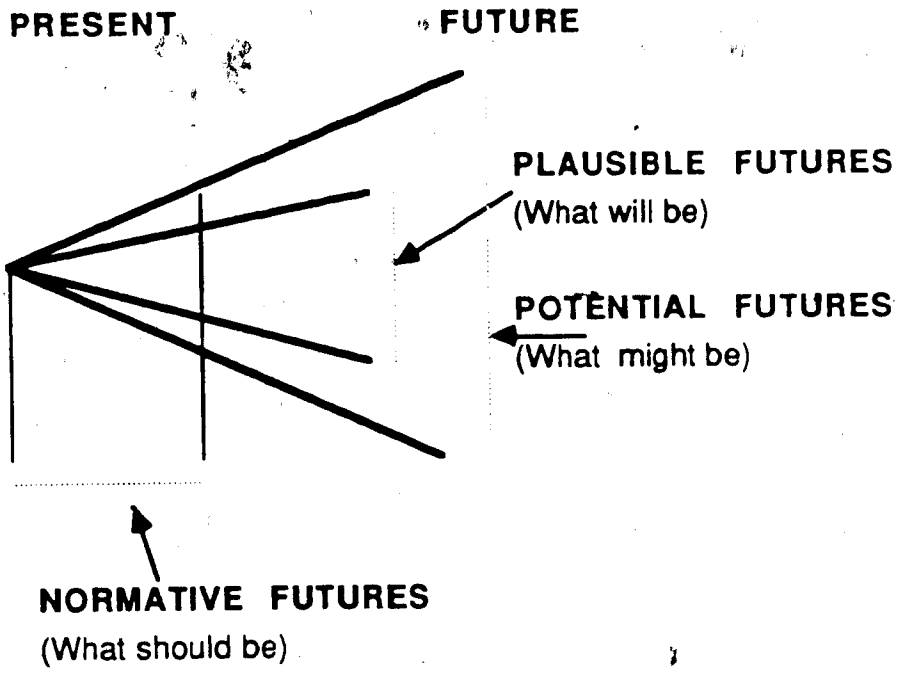
1. The alternatives open to the decision maker; and
2. His preferences among these alternatives.

Essentially the present study deals with first identifying alternative futures related to computer technology and education and then exploring policy alternatives for achieving a desired future.

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: "Therefore the establishment of explicit alternative futures assumptions, to serve as contexts for concrete policymaking, is an important contribution to the improvement of policymaking."

Dunn (1981:143), in a discussion on forecasting policy alternatives, provides a framework for identifying types of pasts as well as types of futures. The portion of the framework which is useful in clarifying the essential elements of the present study is reproduced below.



The present study may be viewed as identifying plausible, potential, and normative futures as well as exploring strategies for arriving at a normative future. It consisted of three distinct rounds or iterations. First, those changes which were either probable or possible within the next five years as a result of the continued influence of computers were identified. Second, a rating was obtained of the desirability and overall probability of those changes identified as either probable or possible. Third, potential patterns for achieving a normative (desired) future were explored.

Summary

This chapter has provided a review of literature and established the conceptual framework for the study. The first section, review of the literature, presented the impact of computer technology as a subset of the overall impact of technology, albeit a very significant one. The potential impact of computer technology on society, individuals, and education were then outlined. Trends and issues related to education were also discussed. Perspectives and recommendations related to educational change were included in the literature review. The second section presented the conceptual framework as identifying alternative futures related to computer technology and education and exploring policy alternatives for achieving a desired future.

The following chapter describes the methodological framework used in the study. It begins by discussing forecasting as a means of identifying policy

alternatives and then discusses the methodology used in the study.

Chapter 3

METHODOLOGICAL FRAMEWORK

In this study, a Policy Delphi methodology was utilized to first identify alternative futures related to computer technology and education and then explore potential strategies for achieving a desired future. The two major sections of this chapter present a discussion of futures forecasting and the Delphi method.

Forecasting

Forecasting is generally accepted as a means of studying alternative futures. These alternative futures may then be used as contexts for concrete policymaking. Quade (1975:240) provides a definition of forecasting: "... to anticipate or predict some future event or condition, usually as the result of rational study or analysis." While acknowledging that forecasting is useful in reducing uncertainty about the future Quade (ibid.:213) also cautions that dealing with uncertainty is one of the most difficult aspects of policy analysis: "No aspect of policy analysis is more difficult to handle than uncertainty." He (ibid.:217) nevertheless adds that while it is extremely difficult to deal with uncertainties the policy analyst cannot afford to ignore them: "What can the analyst do to take account of the proliferation of uncertainties? The most

important advice is: don't ignore them."

While predicting the future can be highly judgemental in nature, a number of writers attest to the usefulness of forecasting. For example, Hussey (1982:71), when referring to corporate planning, outlines the contribution of forecasting:

> My view is that a technological forecast should be interpreted not so much as a prediction of what will happen, but as an indication of what is possible and therefore can be made to happen. Used in this sense it can be seen as a major contributor to strategic decisions, helping the company choose its commitments to the future from a more rational basis. It has particular relevance in research and development strategies. . . .

Quade (1975:241) also acknowledges the role of forecasting in the planning process: "Forecasting plays an important role in the planning process. It helps to identify limits beyond which it is not sensible to plan, it can suggest rates of progress, and it can indicate possibilities that might be achieved."

Dunn (1981:140), when writing about policy alternatives, emphasizes the value of forecasting:

> Forecasting is not only a prerequisite of societal guidance; it also helps policy makers foresee and avoid unanticipated negative consequences of public policy. . . .Forecasting helps provide information that allows us to actively shape the future as well as react to changes projected on the basis of past events. Hence, while the future is partially shaped by the past, it is a product of what we want it to be.

There exists a variety of specific forecasting techniques. Dunn (ibid.:141)

describes three principal forms of these techniques:

1. A projection is a forecast which is based on the extrapolation of current and historical trends into the future.

2. A prediction is a forecast based on explicit theoretical assumptions.

3. A conjecture is a forecast based on subjective judgments about future states of society.

These forms are reflected in three principal approaches to forecasting.

The first approach to forecasting, extrapolation, is commonly used. Dunn (ibid.:151) provides an example of a particular technique, the classical time-series analysis, wherein: ". . .the time series-variable is plotted on the Y-axis (also called the ordinate) and the years are plotted on the X-axis (also called the abscissa)." An example of this technique, often used in the context of extrapolating the future number of microcomputers in Alberta schools, can be found in the Minister's Task Force Report (1983:17). The report (ibid.) reveals surveys where: "In the two year period from the spring of 1981 to the spring of 1983, the number of microcomputers has jumped from 265 to 3,535, an increase of 1,245 percent."

Dunn (1981:175) identifies the second approach to forecasting, theoretical modelling, as ". . . a broad range of techniques and assumptions for constructing simplified representations (models) of theories." It incorporates a number of techniques such as theory mapping, path analysis, input-output analysis, linear programming, regression analysis, interval estimation, and

correlational analysis.

The third approach to forecasting, intuitive, involves subjective judgments. Dunn (ibid.:195) contrasts them with extrapolative and theoretical forecasting techniques: "In contrast to extrapolative and theoretical forecasting techniques, where empirical data and/or theories play a critical role, intuitive forecasting techniques attempt to elicit and synthesize subjective judgments." Dunn (ibid.:195) suggests that the intuitive approach is particularly suited to problems that are ". . . messy, ill structured, or squishy." He further elaborates on three intuitive forecasting techniques: the Delphi, cross-impact analysis, and feasibility assessment.

The topic explored in this study was one for which there existed little "empirical data/or theories," it could be described as "messy, ill structured, or squishy." As there was little available in the form of theory or empirical data, an approach to forecasting based on conjecture was selected as being most suited for the study.

The three techniques, based on a conjecture approach, were examined: the Delphi, cross-impact analysis, and feasibility assessment. Cross-impact analysis was found to be more suited as a "natural extension" (ibid.:206) of Delphi while feasibility assessment was found to be more suited for estimating stakeholders acceptance of already established policy alternatives. The Delphi, which may be viewed as a precursor to the techniques of cross-impact analysis and feasibility assessment, was selected as the technique most suited

for the present study. The following section further describes the Delphi technique.

Delphi

When discussing Delphi, a distinction is often made between Conventional Delphi and Policy Delphi. This section provides a definition and history of the Delphi method and serves to clarify the differences between Conventional Delphi and Policy Delphi. In addition to discussing advantages and disadvantages of the Delphi, considerations for the practitioner are also outlined.

Definition and History

Linstone and Turoff (1975:3) provide a general definition of the Delphi technique: "Delphi may be characterized as a method for structuring a group communication process so that the process is effective in allowing a group of individuals, as a whole, to deal with a complex problem." Dunn (1981:196) provides a similar definition: "Delphi technique is an intuitive forecasting

Soviet planners in estimating the number of A-bombs required to significantly reduce U.S. munitions output. Because of the perceived implications for national defense the information related to Delphi utilization was classified information until the 1960's. After becoming declassified the Delphi enjoyed widespread use in areas such as business, industry, government, and education.

Since the 1960's numerous Delphi studies have been done. Bright (1978:42) reports that "By 1976 hundreds of Delphi studies had been conducted. These ranged from little internal panels to a Japanese nationwide study involving 4,000 panelists." Sackman (1975:5) also observed that ". . . Delphi has spread rapidly, with hundreds of studies appearing in the United States, accompanied by growing use in other countries. . . ." Similarly, Dunn (1981:196) observes: "The Delphi technique has been used by analysts in countries ranging from the United States, Canada, and the United Kingdom to Japan and the Soviet Union." Linstone and Turoff (1975:11) make the same observation: "From America, Delphi has spread in the past nine years to Western Europe, Eastern Europe, and the far East."

Linstone and Turoff (ibid.:75) also suggested that there was a "rich menu of applications" for the Delphi and later provided specific examples in government, business and industry. They advocated the Delphi as primarily a precursor to planning. There is much recent evidence of continued support and interest in the use of Delphi, primarily in the area of planning. Three examples

are provided below:

Dunn (1981:202) outlines the potential contribution of Delphi findings to policy development and decision making: "This report may then be passed on to policy makers, who may use the results of the policy Delphi as one source of information in arriving at decisions."

Phi Delta Kappa's Handbook for Conducting Future Studies in Education (1984) recommends the Delphi as one of several forecasting techniques useful for developing a futures orientation for long-range planning.

Millar (1984:32), also outlines the role of the Delphi in the corporate planning process: "Delphi studies, which are often useful at the outset of the strategic planning process, can be used to collect relevant information so that goals, objectives, strategies, and plans can be formulated." He further observes that "Many major corporations are using the Delphi technique to better understand their current industry conditions, strategic issues facing them, their current competitive positions, and their internal organizational structures."

Recent examples of Delphi applications are studies done by Barrington (1981), and Sellinger (1984), White and Rampy (1983). Barrington (1981:v) utilized a Policy Delphi format to "...identify and explore some of the environmental forces likely to have an impact on the development of policy in the community colleges of Alberta during the period 1980-1990." Sellinger (1984:iv) attempted to utilize a Delphi methodology to identify environmental forces affecting certain departments within two universities as well as explore

programming options. White and Rampy (1983:1) conducted a two round Policy Delphi to identify issues related to education worthy of further study. The main areas of concern identified in the White and Rampy study were used in design of the Round I instrument used in the present study (see chapter 5).

Murray Turoff (Barrington, 1981:69; Linstone and Turoff, 1975:84) is generally credited with making a significant contribution in the area of Delphi studies when he introduced a Policy Delphi in 1969. This departure, while spawning a renewed interest in the use of the Delphi also served to develop a distinction between what is now commonly referred to as Conventional Delphi and Policy Delphi. Each of these forms of the Delphi is described further below.

Conventional Delphi

Dunn (1981:196-197) makes a clear distinction between Conventional Delphi and Policy Delphi. According to Dunn, early Delphis were designed to avoid problems in group communication such as: domination of the group by strong individuals, pressures to conform to group standards, personality conflicts, as well as the difficulties involved with lower ranking individuals opposing persons in higher authority. He characterized Conventional Delphi as having five basic principles: (1) anonymity; (2) iteration; (3) controlled feedback; (4) statistical group response; (5) expert consensus. Sackman (1975:9-10) also included these five principles in his characterization of Delphi.

Bright (1978:41) reduces these principles to just three conditions: anonymity, statistical display, and feedback of reasoning. Barrington (1981:66) stressed "convergence" as a defining characteristic of Conventional Delphi: "A characteristic of traditional Delphis was to provide panel members with group response means and each individual's former answers and suggest revision of estimates."

Sackman (1975:9-10), in addition to including the principles as outlined by Dunn, observed that data may be collected through questionnaires, personal interviews, or on line computer terminals and that the actual items may be generated by either the monitor or participants in the study.

Advantages

The general advantages of Delphi studies have been documented by numerous writers. Weatherman and Swenson (Hencley and Yates, 1974:111-112) provide a comprehensive description of the advantages. They are summarized below:

1. Provides a means of obtaining information from a large number of persons, without the restrictions often imposed by geography and scheduling.
2. Ease of administration and relatively low cost when compared to the expense of convening a similar group.

3. Provides a means of obtaining information about particularly complex phenomena, which are often difficult to conceptualize. Moreover, Delphi is also a simplifying device in itself.
4. It is efficient when compared to other planning procedures because it focuses attention on the desired topic areas and permits a high degree of control by the survey manager.
5. The procedure is often looked upon by participants as an interesting and useful task.

Weaver (1971:271), while critical of Delphi as a forecasting tool, suggests that it has merit in the following educational applications:

> (a) a method for studying the process of thinking about the future, (b) a pedagogical tool or teaching tool which forces people to think about the future in a more complex way than they ordinarily would, and (c) a planning tool which may aid in probing priorities held by members and constituencies of an organization.

Hussey (1982:72) describes the major advantages of Delphi as being: ". . .it stimulates creative thinking and corrects the bias of individual personal judgement without swinging to the other extreme of domination of majority opinion." Finally, Nash (1978:49) suggests two "reasons" why the Delphi is useful as a methodology: ". . . it is a convenient and relatively nontechnical methodology that is appropriate for use with a population not primarily research oriented, and it appears a convenient vehicle for exploring probable and

possible futures in what have been termed 'squishy' areas."

Criticism of Delphi

Two of the most widely acknowledged critics of the Conventional Delphi are Weaver and Sackman. Weaver (1971:270) questioned the notion of "convergence" and suggested that "hope or desirability interferes with and to a considerable extent influences judgments about future events." In order to minimize these concerns he (ibid.) advocated having forecasts make a clear distinction ". . .of what seems 'likely'--given certain factors- -from what we would 'like' to see happen, or 'like' to keep from happening." This distinction, by clarifying the probable and the desirable would reduce problems associated with convergence. Sackman (1975:73-74) concluded his critique of the conventional Delphi with sixteen points which range from the failings of individual practitioners to a sweeping condemnation of the method as being unscientific. Sellinger (1984:56) further reduced the criticisms of Weaver and Sackman to the following points:

1. Delphi's reliance on the opinion of experts is unjustified,
2. attempts to achieve a convergence of opinion among respondents is dysfunctional,
3. suppression of adversary relations is inhibitory,
4. questioning techniques and the responses they generate are inadequate,
5. Delphi's researchers lack precision in reporting results.

Sackman's critique of Delphi has met with rebuttal from different authors.

Coates (1975:193) is highly critical of Sackman's conclusions:

> Sackman ignores the crucial point that Delphi is not a scientific tool, nor is it related to a scientific experiment or a scientifically structured activity. Delphi is not a way of drawing forth expert knowledge on expert's issues, but rather it is an aid to dealing with those most crucial of contemporary societal problems: judgment and wisdom about the future.

For Coates (ibid:194) ". . .the criteria in evaluating a Delphi are not so much that it is right, but that it is useful." Similarly, Linstone (1975:573) discounts much of Sackman's criticism as being narrow, irrelevant and taken out of context:

> Science to Sackman means psychometrically trained social scientists. His tradition-bound attitude is not uncommon; it is in the same vein as the illusion that science is "objective", that only Lockean or Leibnizian inquiring systems are legitimate, and that subjective or Bayesian probability is heretical. Orthodoxy faced with new paradigms often responds with sweeping condemnations and unwitting distortions. Poorly executed applications are brought forth to censure the entire method, quotations are taken out of context, the basis for criticism is left vague, significant supportive research and new directions are ignored, and irrelevant "standards" are applied.

Linstone and Turoff (1975:84) acknowledge problems inherent in earlier Conventional Delphis in that they "tended to deal with technical topics and seek a consensus among a homogenous group of experts." However they advocate the Policy Delphi as a means of overcoming some of the problems inherent in Conventional Delphis. The following discussion outlines some of the major features of the Policy Delphi.

The Policy Delphi

Turoff (1975:84), in comparing Conventional Delphi to Policy Delphi outlines and contrasts some of the major characteristics:

> The Policy Delphi on the other hand, seeks to generate the strongest possible opposing views on the potential resolutions of a major policy issue. In the author's view, a policy issue is one for which there are no experts, only informed advocates and referees. . . . It is unlikely that a clear-cut (to all concerned) resolution of a policy issue will result from such an analysis; in that case, the issue would cease to be one of policy.

He further clarifies the role of Policy Delphis in policy analysis and decisionmaking:

> The Policy Delphi also rests on the premise that the decisionmaker is not interested in having the group generate his decision; but rather, have an informed group present all the options and supporting evidence for his consideration. The Policy Delphi is therefore a tool for the analysis of policy issues and not a mechanism for making a decision. Generating a consensus is not the prime objective, and the structure of the communication process as well as the choice of the respondent group may be such as to make consensus on a particular resolution very unlikely.

Turoff (ibid.:86) viewed the Policy Delphi as being a precursor to, rather than a replacement of, committee activity:

> A Policy Delphi can be given to anywhere from ten to fifty people as a precursor to committee activity. Its goal in this function is once again not so much to obtain a consensus as to expose all the differing positions advocated and the principal pro and con arguments for those positions. In many policy areas, a large number of respondents, in the area of twenty or more, is commensurate with the number of differing interests that must often be considered in the increasingly complex

issues facing organizations.

He (ibid.:87) further clarifies the role of the Policy Delphi as a means of gathering information:

> The Policy Delphi, therefore, is not in any way a substitute for studies, analyses, staff work, or the committee. It is merely an organized method for correlating views and information pertaining to a specific policy area and for allowing the respondents representing such views and information the opportunity to react to and assess differing viewpoints.

Dunn (1981:196) further suggested that the Policy Delphi ". . . is a constructive response to the limitations of Conventional Delphi and an attempt to create new procedures which match the complexities of policy problems." He (ibid.:197) observed that while the Policy Delphi was based on two of the same principles ". . . as conventional Delphi (iteration and controlled feedback) it also introduces several new ones. . . ." These principles, which are not necessarily reflected in all studies, are outlined further below:

1. Selective Anonymity: Participants in a policy Delphi remain anonymous only during the initial rounds of a forecasting exercise. After contending arguments about policy alternatives have surfaced, participants are asked to debate their views publicly.
2. Informed Multiple Advocacy: The process for selecting participants is based on criteria of interest and knowledgeableness, rather than "expertise" per se. In forming a Delphi group investigators therefore attempt to select as representative a group of informed advocates as may be possible under the circumstances.
3. Polarized Statistical Response: In summarizing individual judgments, measures that purposefully accentuate

disagreement and conflict are used. While conventional measures may also be used (median, range, standard deviation), policy Delphi supplements these with various measures of polarization among individuals and groups.

4. Structured Conflict: Starting from the assumption that conflict is a normal feature of policy issues, every attempt is made to use disagreement and dissension for creatively exploring alternatives and their consequences. In addition, efforts are made to surface and make explicit the assumptions and arguments that underlie the contending positions. The outcomes of a policy Delphi are nevertheless completely open, which means that consensus as well as a continuation of conflict might be results of the process.
5. Computer Conferencing: Where possible, computer consoles are used to structure a continuous process of anonymous interaction among physically separated individuals. Computer conferencing eliminates the need for a series of separate Delphi rounds.

The present study utilized a Policy Delphi methodology to first identify alternative futures related to computer technology and education and then explore policy alternatives for achieving a desired future. A Delphi methodology was chosen because it appeared most suited for forecasting alternative futures. More specifically, a Policy Delphi methodology was chosen because:

1. The conceptual framework had been established in a context of policy analysis and the methodology was consistent with achieving the purposes of the study.
2. The Policy Delphi methodology was viewed as a constructive response to the limitations of Conventional Delphi.

Considerations for Conducting a Delphi

Practitioners of the Delphi often find themselves beset with problems and pitfalls in the actual application of the technique. The following is a discussion of some of the common problems and pitfalls.

Bright (1978:42) makes a number of practical comments "based on the reactions and collective experiences of several hundred Delphi participants and study directors." First, conducting a Delphi is time-consuming. Second, there are often difficulties maintaining panelists support. Third, choosing the experts is often a problem as the study organizers (ibid.:43) "may not know the best people in the field." As experts in a single area are not necessarily best suited for a Delphi Bright (ibid.:43) recommends seeking "collective wisdom across disciplines" and "organizations." Finally, both asking the proper questions and interpreting the final data requires time and effort on the part of the study designer. Included in these comments is the concern that (ibid.:44): "The stress on achieving consensus has been overdone." There is a further danger of the forecast user believing that consensus data, especially if presented statistically, represents some form of "truth." Bright (ibid.:44) concludes that "Despite these criticisms and potential problems, Delphi provides a very useful way to bring future-oriented thinking into the organization of possibilities that may be otherwise ignored."

Linstone (1975:574-586) also provides constructive criticism in the form of eight basic pitfalls that the practitioner might use as a checklist when

conducting a Delphi. These pitfalls are briefly summarized below:

1) Discounting the Future includes the tendency of people to ignore problems with long time horizons in the hope that they will either vanish or new solutions will be discovered to deal with them. 2) The Prediction Urge occurs because of most peoples' predilection for certainty. While some Delphi's have a tendency for certainty, Linstone (ibid.:578) sees prediction as "far less important than alternatives and differences in views of the future," especially if the technique "is viewed as a two-way communication system rather than a device to produce consensus. . . ." 3) The Simplification Urge includes mar peoples' tendency to simplify things without considering the holistic pattern. 4) Illusory Expertise refers to the sometimes illusion that expertise in a certain area insures a good forecast. Linstone (ibid.:581) cites examples of reciprocating engine experts of the 1930's who forecast "propeller aircraft would be the standard up to 1980." 5) Sloppy Execution may occur as a result of actions of either the analyst or participants. The analyst can make errors in selecting participants, formulating Delphi statements, analyzing responses, and failure to use a basic lack of imagination when designing the study. 6) Optimism-Pessimism Bias occurs (ibid.:584) when there is ". . .a bias toward overpessimism in long-range forecasts and overoptimism in short range forecasts." 7) Overselling occurs when users are led to believe that the Delphi can deliver more than it was designed to do. This problem is complicated further when analysts (ibid.:584) urge use of the Delphi "for practically every

use except cure of the common cold." 8) Deception (ibid.:585) is "the least acknowledged hazard" of the use of Delphi. There is the potential to use Delphi for deceptive, manipulative purposes.

Linstone (ibid.:586) in acknowledging that the Delphi, like other communication processes, has problems suggests that: "While the Delphi designer in the context of his application may not be able to deal with, or eliminate, all of these problems, it is his responsibility to recognize the degree of impact which each has on his application and to minimize any that might invalidate his [illegible].

In conducting the present study, attempts were made to eliminate or minimize many of the identified concerns related to the Delphi method. Particular attention was given to concerns identified in the Alberta studies conducted by Barrington and Sellinger. In relation to the Delphi methodology Barrington (1981:265) concluded that while the Delphi method was an appropriate tool for policy analysis a major limitation was that it was physically unwieldy: ". . . a lot of time was taken up by late responses and losses in the mail. The data generated were of enormous bulk and the collation of information was a lengthy process." Sellinger (1984:iv) encountered a very high dropout rate in the first round which made necessary a departure "from the conventional Delphi format." (Additional respondents were added to Round II and interviews were conducted with selected respondents in Round III in lieu of questionnaires). In relation to the methodology he (ibid.:197) concluded that

"Applications of the conventional form of the Delphi method should be avoided except in situations in which the respondents are under a real obligation to cooperate." He (ibid.) further recommended that "Studies should be carried out which have as their purpose the refinement of the Delphi technique."

Finally, neither Helmer, one of the original developers of Delphi, nor Linstone and Turoff, influential advocates of the Policy Delphi, viewed existing applications of the technique to be in a highly refined form. Helmer (Linstone and Turoff, 1975:xix) observed that "Delphi has come a long way in its brief history, and it has a long way to go." Linstone and Turoff (ibid.:3) reinforce this view: "For a technique that can be considered to be in its infancy, it would be presumptuous of us to present Delphi in the cloak of a neatly wrapped package, sitting on the shelf and ready to use. Practitioners of the Delphi can find themselves besieged with many problems. Linstone and Turoff also provide a descriptive comment (ibid.) which summarizes the intricacies of designing a successful Delphi: ". . . if anything is 'true' about Delphi today, it is that in its design and use Delphi is more of an art than a science."

Summary

This chapter presented a discussion of futures forecasting and the Delphi method. Forecasting was presented as a means of studying alternative futures that could be useful as contexts for policymaking. The Delphi was presented as an iterative procedure which allows a group of individuals to collectively

address complex problems. It was observed that while defining characteristics of Delphis include iteration and controlled feedback a distinction is often made between Conventional Delphi and Policy Delphi. Policy Delphi was presented as a means of overcoming problems inherent in earlier Conventional Delphis, a major distinguishing feature being that Policy Delphi does not strive for consensus.

Chapter five provides a description of the research design and procedures utilized in the present study. However, before proceeding with describing the research design, chapter four further establishes the context for the study by discussing recent initiatives related to educational computing in the province of Alberta.

Chapter 4

THE ALBERTA ENVIRONMENT

Within the province of Alberta there exists an environment of significant support for computers in education. Stephen Jobs (1985) when speaking of the Alberta situation with regard to computers suggested that: "You've got a great opportunity here, in terms of your educational expertise, you're definitely in the top five places in the world right now, especially right here, in terms of the integration of computers into the schools." The two sections contained in this chapter describe the Alberta environment with regard to microcomputers in education. The first section relates the most recent findings of a microcomputer survey of schools. The second section reviews recent provincial initiatives related to educational computing.

Microcomputer Survey-1985

A recent study conducted in January of 1985 by Petruk surveyed all schools in Alberta to determine the usage of microcomputers. Of 1509 questionnaires sent to schools in this survey 1271 were returned, providing a response rate of 84.23%. The schools responding represented 22,314 teachers and 383,152 students. This survey (Alberta Education, Fall 1985) is of significance to the present study in two primary areas. First, both studies were

conducted at approximately the same time, thus the survey's findings reflect the environment at the time of the present study. Second, it is the most accurate and up to date representation of microcomputer activity within Alberta schools. Its major findings are reported in detail below.

The following table presents the actual number of reported micro-computers in Alberta schools and the projected number for the total population:

Table 4.1

Number of Computers in School

Type	Number Reported	Number Projected
Apple II (Family)	9889 (71.9%)	11741
Mac (Family)	47 (0.3%)	56
PET (Family)	1979 (14.4%)	2350
VIC	292 (2.1%)	347
IBM (Family)	869 (6.3%)	1032
TRS (Family)	170 (1.2%)	202
Other	502 (3.2%)	596
TOTAL	13,748	16,324

The survey reports an overall average of 27.87 (using figures from the schools that responded) students per computer.

Table 4.2 presents the total number of computers being planned for the next fiscal year.

Table 4.2

Planned Acquisition in the Next Fiscal Year

Type	Number Reported	Number Projected
Apple II (Family)	4742 (69.1%)	5630
Mac (Family)	47 (0.6%)	56
PET (Family)	355 (5.2%)	421
VIC	44 (0.6%)	52
IBM (Family)	1470 (21.4%)	1745
TRS (Family)	25 (0.4%)	30
Other	176 (2.6%)	209
TOTAL	6859	8143

When incorporating the number of computers planned for the next fiscal year the survey reports an overall average of [redacted]using figures from the schools that responded) students per computer.

Table 4.3 presents a description of the number of students per computer according to school type.

Table 4.3

Number of Students Per Computer

Number of Students Per Computer	Elementary	Jr. High	Sr. High
At Time of Study	42.4	44.4	19.6
Planned in Next Fiscal Year	27.9	26.6	12.5

In terms of access to computers 94.6% of the 1271 schools had at least one microcomputer. However, an analysis of student population figures indicates that less than 1% of the student population attend schools that have no microcomputers. Of the 69 schools without computers, all tend to be small in size and 38 of those 69 serve a religious minority.

Microcomputers tend to be located in a variety of configurations. Table 4, included on the following page, provides a description of the location of microcomputers in schools.

Table 4.4

Location of Microcomputers in Schools

Location	Number of Schools	Number of Microcomputers
Microlab	516	5830
Resource Room	360	878
Admin. Office	390	468
Classroom	435	1835
Transport	496	1592
Industrial Ed.	79	232
Business Ed.	128	2369
Other Locations	155	457
TOTAL		13,661 (*87 not accounted for)

Table 4.5 presents the reported usage of computers in administration.

Table 4.5

Administrative Usage of Microcomputers

Type of Use	Number
Not Used	665 (44.7%)
Attendance	115 (9.[illegible])
Grades	318 (25.0%)
Report Cards	106 (8.3%)
Class Scheduling	55 (4.3%)
Financial Records	182 (14.3%)
Word Processing	440 (34.6%)
Electronic Mail	38 (3.0%)
Other	204 (16.0%)

The survey also attempted to determine the number of schools which incorporated some form of computer assisted instruction (CAI) and which had teachers who could write computer programs (The questionnaire did not define CAI and the criteria for a program was that it was being used for instruction or administration). The responses are listed below:

Number of Schools using CAI:	1020/1271=	80.25%
Number of Teachers using CAI:	5938/22314=	26.61%
Number of Schools having teachers who write programs:	601/1271=	47.29%
Number of teachers who write programs:	1376/22314=	6.17%

In terms of computer applications, and using information supplied from schools that were clearly designated as either elementary, junior high or senior high, the survey indicated the following: Elementary schools tend to teach computer literacy and LOGO. Junior high schools tend to use computers for computer literacy. Twenty-five per cent of the responding high schools teach computer literacy and 71% reported teaching computer processing.

In summary, there exists a significant number of microcomputers within Alberta. This number is likely to increase nearly 50% within the next fiscal year (according to existing plans the number of computers are projected to increase from an estimated 16,324 to 24,467). The existing overall ratio of students per computer is 27.87 and will likely decrease to 18.59 within the next fiscal year. Less than 1% of Alberta students attend schools that do not have microcomputers, these schools tend to be small in size--a large proportion serving a religious minority. The ratio of students per computer is significantly lower in senior high than it is in either the junior high or elementary school. The machines are located in a variety of configurations. Elementary schools use computers primarily for literacy and LOGO, junior high schools use them primarily for literacy, and senior high schools use them primarily for computer processing and literacy.

Initiatives Related to Educational Computing

The province of Alberta has witnessed numerous innovative

developments related to educational applications of computer technology. For example, the early work of Dr. Hunka and the Division of Educational Research Services at the U of A has received widespread recognition for being at the early forefront of research in Computer Assisted Instruction. The U of A's PLATO system, and more recently, the U of C's acquisition of a supercomputer, are also often cited as examples of innovative developments within Alberta. While acknowledging that much could be written about projects such as these, this section concentrates more specifically on policy initiatives related to computers in public education.

Early Activities

Early activities, at the provincial level, related to educational computing began with Alberta Education's involvement just prior to 1980. At that time Hallworth and Brebner (Alberta Education, 1980) were commissioned to report on computer assisted instruction in schools. A short time later M. Petruk (Alberta Education, 1981) was also commissioned to carry out a study on microcomputers in Alberta schools.

Hallworth and Brebner reported that we were in the midst of a "technical revolution" in which the computer would play a central role. They concluded that as the use of CAI improved student achievement its applications should be further exploited in education. Petruk (ibid:20) concluded that despite the newness of the technology a "substantial segment of the educational

community in Alberta has been able to respond to this technological impact by providing both equipment and programs on their own initiative." These studies set the stage for a major policy announcement made by the Minister in 1981.

In October of 1981 the Hon. David King, Minister of Education, announced that ". . . the government has made a policy decision to proceed with systematic activities meant to advance the use of computers in our schools." When making this policy announcement the Minister also acknowledged that there already existed initiatives in schools and that it was the government's intent to support those existing initiatives: "In this context we will also encourage and support those who are already using computers." A news release, issued later that day, outlined the following initiatives:

1. the Computer Technology Project to handle all activities related to computers in the province
2. preparation, by the Curriculum Policies Committee, of a draft computer literacy curriculum for elementary, junior high and senior high schools for piloting in the fall of 1982
3. a hardware standard which will allow all schools with the same computers to use the same computer courses
4. provision for computer orientation and inservice programs for teachers and administrators
5. the establishment of a clearinghouse of computer materials for schools which will search "the market for, buy and test computer programs written for schools and assist the production and distribution of courseware.

(The Technology Project was initially funded for a total of three years. Some of its initiatives were modified in the Fall of 1984 when aspects of the Project were either disbanded or placed within regular departments.)

Within the same announcement the Minister alluded to the creation of a Task Force on Computers in Education. The Task Force was not established until November 16, 1981 and it was not formally announced until July 9, 1982. The Task Force's mandate, as cited in the official News Release (1982), was "to advise the Minister on policies, programs, services and other matters related to computers in schools." The recommendations were to represent a desirable level for use of microcomputers in Alberta schools in a three to five year period. The Task Force, and its findings, are further elaborated in the next sub-section.

The Minister's Task Force

Thirteen individuals, representing a variety of interest groups, were appointed to serve on the Task Force. It contained representatives from the Alberta School Trustees' Association, Alberta Teachers' Association, Conference of Alberta School Superintendents, Alberta Society for Computers in Education, Association for Educational Data Systems, Alberta Education, Alberta Advanced Education and Manpower, Canadian Information Processing Society, Curriculum Policies Committee, two members from the public at large, and Alberta universities.

On July 5, 1983 when the Minister released the Task Force Report on Computers in Schools. The Task Force made recommendations regarding seven issues in areas which they perceived to be of concern. These recommendations and issues will be briefly described.

The first issue dealt with students and curriculum. The Task Force recommended that students have regular access to computer learning stations in schools by 1985 and that the department initiate a review of the program of studies to accomodate the new technology in it.

Teacher training was the second issue. Eight recommendations were provided. The report indicated that the various Faculties of Education in Alberta's universities provide computer literacy courses and that further, these courses be compulsory in order to obtain certification as a teacher in Alberta. The Task Force also recommended that incentives be provided so that inservice programs, as well as graduate programs, could be established for interested individuals currently in the system.

The third issue was courseware. Twelve recommendations were made in regard to evaluation, distribution, development and production within the province. A major recommendation being that the clearinghouse facility, presently in operation, be maintained.

Hardware was the fourth issue addressed. Eight recommendations were made. The report dealt with evaluation, acquisition, distribution and placement of hardware. Computer network systems as well as peripherals for handicapped were also addressed.

Planning was identified as a fifth issue. Here, the Task Force stipulated that "Alberta Education develop a comprehensive, strategic, provincial plan for educational computing, which shall be reviewed at least once per year." In

addition to stressing planning at the provincial level the report also stressed the need for planning at the school-jurisdiction level.

The sixth issue pertained to organization. The report stressed the establishment of an Educational Computing Branch that would be "durable enough to be stable and reliable, yet flexible enough to adapt to change. . ." In addition, the creation of computer consultant positions at each of the regional offices was recommended as well as the establishment of an Advisory Committee to "review directions, policies, programs, services, and other matters related to educational computing."

The final issue addressed was that of funding. The Task Force recommended that Alberta Education provide most of the funding required to implement its recommendations.

Of all the computer related activities and initiatives in the province, the Minister's Task Force could be categorized as the most ambitious attempt to influence policy regarding computers in education. Recent initiatives, many of which could be interpreted as a response to recommendations in the Task Force, are discussed in the following sub-section.

Recent Initiatives

Recent initiatives related to computers in eduction are discussed under the following headings: funding, curriculum, research, and ongoing support.

Funding

In an information bulletin released May 2, 1984 regarding grants to schools there were several funding announcements which are related to computers (see Figure 2).

S. J. Thiessen (1984:5), Director of Alberta Education's Technology Project elaborated on the grant system outlined in Figure 2:

> This year, 1984, the provincial government decided to assist school districts who wish to purchase microcomputers for use in their business education programs. Part of the funding allocated to this activity will be used for microcomputers at the elementary and junior high school levels. In this particular program, the provincial government will match, on a dollar for dollar basis, the money invested by the local school jurisdiction. A funding floor and ceiling are built into the program. School systems are encouraged to document their planning activities relative to the educational use of computers, as part of receiving their grant.

This funding, often referred to as BQRP (Building Quality Restoration Program), allows for approximately 30 million dollars to be spent on educational computing equipment over a three year period (1984-87). This funding, contingent upon a 50/50 cost sharing formula, means that if school jurisdictions match the department grant, approximately 60 million dollars will be spent on computing equipment under provision of the grant.

Another grant which could be interpreted as related to computers is the one outlined for teacher inservice (see Figure 3). The teacher inservice grant was also further clarified by Thiessen (1984:5): "Another additional provincial government funding project this year (1984) is the designation of a small grant

to each school system for professional development of their teachers." Thiessen also suggested that one of the designated priority areas for 1984-85 was educational computing.

An additional grant, just recently announced (Alberta Education News Release, Jan. 8,1985) was a one-time learning resources grant to support the purchase of courseware: "Additionally, a one-time learning resources material grant totalling $4.5 million will assist school jurisdictions substantially in the acquisition of library materials and computer courseware for existing computers and for those being purchased."

Curriculum

There have been a number of developments related to the area of curriculum. As noted earlier, the Minister announced the establishment of a Curriculum Policies Committee in 1981 that was to have junior and senior high school computer literacy programs ready for piloting in the fall of 1982. These programs took longer to develop than the Minister had anticipated, however, to date there exist five computer related curriculum documents available through Alberta Education. Each of these five documents will be identified and briefly described below.

1. A 1983 document titled Implementing Computer Literacy Programs in Schools which is designed to (1983:i) "assist

administrators in implementing computer literacy activities in a school jurisdiction and/or a school."

2. A 1983 curriculum guide titled Elementary Computer Literacy which outlines a computer literacy program for students in grades four, five, and six.
3. A 1984 curriculum guide titled Junior High Computer Literacy.
4. A 1984 curriculum guide titled Computer Literacy 10.
5. A 1984 curriculum guide titled Computer Processing 10, 20, 30.

Research

In addition to the initiatives outlined above, Alberta Education has maintained an ongoing involvement in activities related to research on educational computing. As well as the reports by Hallworth and Brebner, and Petruk (cited earlier), other reports related to computing include the following:

1. A 1982 report, Computers in Education, which provides general information about microcomputers and their applications in an educational setting.
2. A 1983 study, Implementing Computer Technology in School Systems, dealing with the implementation of computer technology in a small school system. The report discusses policy recommendations as well as implementation strategies.

3. A 1983 study, Utilization of a Microcomputer in the Elementary School Learning Resource Centre, which studied the effects of computerized learning resource system in an elementary school.
4. A 1983 study, Utilization of Microcomputers in Elementary Mathematics, which monitored the possible benefits of using a microcomputer in an elementary mathematics program.
5. A 1983 study, Using the Computer to Teach Language Arts (Spelling).
6. A 1984 study, Evaluation of the Alberta Correspondence School Computer-Managed Learning Project, examined the effectiveness of computer-managed learning in distance evaluation.
7. A 1984 study, Computer Inservice for Teachers: The Medicine Hat Consortium, monitored teacher inservice courses over a two year period and made a number of recommendations regarding future courses.
8. A 1984 report, Images of the Future, while not directly related to educational computing, contains an informative section on the impact of technology.

Another study worthy of note was Alberta Education's Review of Secondary Programs: Report of the Minister's Advisory Committee: Foundation for the Future (1985:24) that suggested: ". . .the present and future

orientation of education would be well served by developing the computer literacy of students. Alberta Education should provide leadership in developing computer technology in the classroom." The report (ibid:24) also made the following recommendations:

> -Computer literacy be developed and integrated throughout school programs, using computers for data storage, word processing, educational networks, distance education and computer assisted education.
> -The government take necessary initiatives to promote the development of education software relevant to the secondary education curriculum.

Ongoing Support

There is much evidence of a continued ongoing support for computers in education. At a recent press conference, called by Premier Lougheed and Education Minister David King, computers were identified as one of the fundamental areas requiring support in education. Lougheed was quoted (Edmonton Journal, June 13, 1985, p. 1) as saying "It is clearly apparent that a firmer foundation in the sciences, mathematics, computers, communications, history and geography is essential." Perhaps of greatest significance for computers in education is that they appear to be achieving recognition along with other "basics".

One of the larger department initiatives was the Technology Project. As noted earlier, elements of the project were either disbanded or regularized within the department. This change from a project status to regularization could

be viewed as evidence of a more permanent continuing support. Two important aspects that were continued were the Clearinghouse and inservice functions. The Clearinghouse, with primary responsibility for courseware evaluation, became part of the Curriculum Branch. Responsibility for inservice became that of the Program Development Division. Another more recent development (June, 1985) has been the creation of the position of Associate Director within the Media and Technology Branch which will include computers as an area of responsibility.

In summary, this section has provided a description of recent Alberta initiatives related to educational computing. Largely because of a strong degree of political and economic support Alberta Education has been able to support the large scale acquisition, implementation, and use of computers in schools.

Summary

The preceding chapter has provided a discussion of the Alberta environment with respect to computers in education. Essentially there exists an environment of significant support. Schools have already obtained a large number of computers and it is likely that these numbers will increase by significant proportions within the next year. Computers are being made available at all grade levels and are presently used for numerous applications. Alberta Education has exhibited leadership in a variety of areas related to

educational computing. This leadership has been aided by strong political and economic support.

Chapter 5

RESEARCH DESIGN AND PROCEDURES

In this chapter a description is provided of the research design and procedures utilized in the study. The first section on research design includes a statement of purpose, and a description of the panel selection. The second section, on research procedures, includes a description of the pilot study as well as a description of the instrument development, data collection procedures and data analysis procedures for each of the three rounds of the study.

Research Design

Statement of the Purpose

The purpose of the study was to identify those changes in education which were both probable and possible through the introduction of computers and identify potential patterns for achieving a normative (desired) future. Specifically, the following questions were asked:

1. What changes are both probable and possible in education within the next five years as a result of the influence of computers?
2. What is the desirability and overall probability of those changes identified as either probable or possible?

3. What are the potential patterns for arriving at a normative (desired) future?

The study had as an additional purpose a further refinement of the Delphi methodology.

Panel Selection

Participants in the Policy Delphi study were selected through a two-step process. The first step in the process involved a pilot study followed by nominations for the Dephi panel.

Preliminary data were obtained through a pilot study with six educators who were involved with computers. The individuals who participated represented different organizations (see Appendix A) and were selected on the basis of their involvement with computers.

An "expanding nucleus" (Hussey, 1982:72) procedure was used to select Delphi participants. The first step in selection of the panel involved inviting the original six participants in the pilot study to take part in the Delphi study. All six agreed to participate. These six individuals were then interviewed using the interview schedule for Round I. At the end of the Round I interview, when it was felt that interviewees would have a clearer understanding of the study, each was asked to nominate other potential participants . Participants were directed to nominate only those individuals who met the following criteria:

1. Knowledgeable about computers.

2. A background in education.
3. Willingness to participate.
4. Representation from a variety of organizations.
5. Availability within a reasonable commuting distance.

A total of fifty-one nominations were obtained.

From the fifty-one nominations received, fourteen individuals were selected as being potential candidates for participation in the study. Selection was made on the basis of the following criteria:

1. Number of nominations received.
2. Obtaining a group which included representation from a variety of organizations.

The fourteen individuals were approached and all agreed to participate in the study. Two individuals were not included in the study after discussion revealed that they had commitments inconsistent with the time-frame of the study. The remaining twelve individuals, combined with the six participants who had been identified previously, comprised the Delphi panel (see Appendix B). Table 5.1 depicts the number of participants in Round I of the Delphi and the organizations they represented.

Table 5.1

Number of Participants and Organizations Represented

Number of Participants	Organization
5	Central Office
4	Government Departments
2	Industry
4	In-School Personnel
3	University
Total 18	

* The specific job titles of individuals who participated in the study are provided in Appendix B.

In summary, a total of eighteen individuals with a knowledge of computers and a background in education were selected to participate in the study. These individuals represented a variety of organizations as well as different levels of involvement in education. They were identified through a two-step selection procedure.

Research Procedures

Information for this study was collected through a preliminary pilot followed by a three round Delphi. This section will describe the pilot study as well as each of the three rounds of the Delphi study.

The Pilot Study

The pilot study had three main purposes. The first purpose was to explore concerns related to the impact of computers upon education. A second purpose was to help conceptualize the problem to be explored in the major study and aid in development of the Round I instrument. The third purpose was to test methods of data collection.

Interviews ranged in length from forty-five minutes to one and one-half hours. All interviews were semi-structured, and participants were allowed a great deal of freedom to express any concerns, both immediate and future, they might have related to the impact of computers. Different methods of recording data were used. For three of the interviews a tape recorder was used and transcripts made of the interviews. For the remaining three interviews, extensive notes were kept.

Data collected in the interviews were categorized and synthesized in order to identify some emerging general themes related to education. These themes were used in development of the Round I instrument.

The Policy Delphi

Each of the three rounds of the Policy Delphi are described below under identical headings: instrument development, data collection procedures, and data analysis.

Round I

Instrument Development. The interview schedule for Round I was developed from three primary sources of information: The Minister's Task Force Report (1983), the pilot study, and a study done by White and Rampy (1983) for the U.S. Agency for Instructional Television. The procedure used to develop the interview schedule is described below.

Each of the three sources of information was reviewed to identify areas of concern in relation to computers and education. A list of the main areas of concern was developed. Broad categories were created from this review. A matrix was then developed wherein areas of concern for each source of information were cross-checked with the broad categories. Table 5.2 depicts the matrix used.

All three sources of information identified similar categories to be important areas of concern in relation to computers and education. Five broad categories were created as topics for the interview. Under each category participants were asked to consider the next five years and identify what they

Table 5.2

Educational Areas of Concern Related to Computers

	Acquisition and funding	Courseware	Curriculum	Organizat-ions	Teacher Training
MINISTER'S TASK FORCE					
1. Students and Curriculum			x		
2. Teacher Training					x
3. Courseware		x			
4. Hardware	x				
5. Planning				x	
6. Organization				x	
7. Funding	x				
PILOT STUDY					
1. Curriculum			x		
2. Courseware		x			
3. Organizational Change				x	
4. Financial Resources	x				
5. Teacher Education					x
A.I.T. STUDY					
1. Curricular			x		
2. Courseware		x			
3. Teachers					x
4. Roles of External Agents					
5. Acquisition and Funding	x				

foresaw as both the plausible future and the potential future. In addition, a sixth category was included in the interview schedule wherein participants were invited to identify any other areas which they felt to be of importance to the study of computers and education.

Data Collection Procedures. Data for the first round was collected in two stages. The original six participants in the pilot study were interviewed first in order to obtain nominations for the remainder of the panel. The remaining twelve participants were interviewed after the nomination and selection procedure was completed. It took six weeks to complete the interviews.

Interviews were conducted by the researcher at the workplace of the participant. With the exception of the nomination procedure which followed the first six interviews, the same procedure was followed in all 18 interviews. After a general discussion at the beginning of the interview participants were provided with three documents: (1) A general introduction to the study. (2) An explanation of the purpose and procedures of the interview. (3) The interview schedule (see Appendix C). The interviews were taped. Notes were also taken by the researcher during the interview.

Data Analysis. Qualitative methods of data analysis were utilized to analyze Round I interview data. A major task in the data analysis was to condense the information collected in the interviews into a manageable size

suitable for the Round II questionnaire. Interview data were summarized, categorized, and synthesized. The procedures employed are elaborated below as a series of steps.

Step 1. As soon as possible after each interview, (generally within a day) the researcher reviewed the interview notes and replayed the tape that had been recorded. A new set of extensive notes was made from reviewing original notes, replaying the tape several times as well as transcribing pertinent sections.

Step 2. The extensive set of notes was then analyzed to identify significant statements about the future. A total of 798 statements about the future were identified and entered on a microcomputer word processing program.

Step 3. The 798 statements were reviewed individually and descriptors assigned to them.

Step 4. With the aid of a "cut and paste" feature of the microcomputer word-processing program, the 798 statements were re-arranged according to descriptor categories.

Step 5. Each category was then reviewed separately and repetitious statements as well as those not directly related to the future of educational computing were eliminated. A total of 398 statements were eliminated. 450 statements remained.

Step 6. Each category was again reviewed separately and repetitious

statements as well as those not directly related to the future of educational computing were eliminated. A total of 164 statements were eliminated. 286 statements remained.

Step 7. Each category was again reviewed separately and repetitious statements as well as those not directly related to the future of educational computing were eliminated. A total of 86 statements were eliminated. 200 statements remained.

Step 8. Each category was again reviewed separately and repetitious statements as well as those not directly related to the future of educational computing were eliminated. Those statements that were closely related were also combined. A total of 52 statements were eliminated or combined with other statements. 148 statements remained.

Step 9. Two other individuals were asked to review the 148 statements and were given the following instructions: (1) Indicate those statements which are either repetitious or closely related. (2) Indicate those statements which you feel are not directly related to the future of educational computing. A final review of the statements, along with feedback provided by these individuals, facilitated the removal of an additional forty-eight statements.

In summary, eighteen individuals were interviewed in Round I and asked

to identify those developments in education over the next five years, which were either plausible or for which there was potential as a result of the continued introduction of computers to education. 798 statements about future developments in education as a result of the continued introduction of computers were generated from the interview data. These 798 statements were compressed into 100 statements. The total time involved in completing Round I was ten weeks.

Round II

Instrument Development. The Round II instrument (see Appendix D) consisted of a questionnaire containing 100 items grouped into eight categories. There was also a ninth category where respondents were invited to make additional comments related to the study. Each of the 100 items was in the form of a statement about the future accompanied by two five-point rating scales for measuring probability and desirability. The rating key was explained in the instructions.

The Round II questionnaire initially contained 100 statements, derived from analysis of the Round I data. These statements were included in a draft of the Round II questionnaire. The draft version of the questionnaire was reviewed by a number of individuals. First an expert in data analysis was consulted regarding the appropriateness of the questionnaire format. The

format was found to be quite acceptable, however, suggestions were made regarding modifications that would allow for greater ease when keypunching information for analysis. Second, the draft version of the questionnaire was field tested with two doctoral students, a thesis committee member, and the researcher's advisor. These individuals were asked to comment on the overall questionnaire format, rating key, clarity of instructions and time to complete. The individuals reported that they had little difficulty with the format or instructions and that it took approximately 45 to 60 minutes to complete. Suggestions were also made regarding the rating key. All suggestions made regarding the improvement of the draft questionnaire were incorporated into a final version.

The final version of the questionnaire was reviewed by two doctoral students and the researcher's advisor. All agreed that the questionnaire was ready for distribution.

Data Collection Procedures. Throughout the period of questionnaire distribution and collection, attempts were made at maintaining personal contact. All questionnaires were delivered within a two day period. Distribution was accomplished in the following manner:

1. One questionnaire was mailed.
2. In two cases, where out of town travel was involved, prior arrangements were made and the questionnaires were completed while the researcher waited.

3. In eleven other cases the researcher was able to speak directly to the participant. No instructions were given other than those accompanying the questionnaire. Participants were encouraged to complete the questionnaire and told that they would be contacted within a few days regarding their progress.
4. In four cases the questionnaires were left with a secretary or colleague of the participant.

Eight days after the questionnaires were distributed attempts were made to contact participants via telephone or in person. Within ten days of initial distribution 14 completed questionnaires had been collected by the researcher. It took an additional eleven days for completion and pick-up of the remaining four questionnaires. Table 5.3 represents the number of contacts made and the time taken for completion of the questionnaires. In summary, it took a total of three weeks from the time of initial distribution until final completion of the second round questionnaire. The participation rate was 100%.

Table 5.3

Time Taken to Complete Round II Questionnaires

	First Contact	Second Contact	Third Contact
People Contacted	18	4	3
Questionnaires Completed	14	1	3
Time Elapsed Since Distribution	8-10 days	13	15-21
Total number of Questionnaires Completed	14	15	18

Data Analysis. Quantitative and Qualitative methods were utilized to analyze Round II questionnaire data. An essential component of the data analysis involved placing Round II questionnaire items into categories on the basis of participant ratings of probability and desirability. The procedures utilized are described below.

First, all of the information from the questionnaire items was recorded on a computer. While each questionnaire item required two separate responses wherein the respondent had five choices for each response, the information entered onto the computer was reduced to three categories for each response: positive, uncertain, and negative. A frequency count was done for each of the items and the information cross-tabulated. A cross-tabulation printout was obtained for each questionnaire item (a sample printout is included in Appendix E). A 3x3 matrix was then created to represent all of the possible categories of responses and display the information for each item. Table 5.4 represents the matrix used for each item.

Table 5.4

Round II Matrix

	Highly Desirable	Uncertain	Highly Undesirable
Highly Probable			
Uncertain			
Highly Improbable			

There were three steps involved in placing information on the matrix. Each item was analyzed separately and placed on the matrix according to pre-established criteria. The criteria, which is described further below, was changed for each step. Table 5.5 depicts each of the steps and the number of items placed in each category of the grid.

Table 5.5

Matrix Classification of Round II Questionnaire Items

	Highly Desirable	Uncertain	Highly Undesirable
Highly Probable	Step 1: 48 Step 2: 14 Step 3: 3 Total: 65	Step 3: 2	Step 1: 7 Step 2: 6 Step 3: 3 Total: 16
Uncertain	Step 3: 4		Step 3: 7
Highly Improbable			Step 1: 1

* There were five "scattered" items which did not fit into any of the categories above.

Items were placed on the grid in the following sequence of steps:

Step 1. Using 66-100% as a level of agreement wherein each individual agreed on the probability and desirability of an item, items were placed in three cells on the matrix: 48 statements were in the high probability/highly desirable cell, 7 statements were in the high probability/highly undesirable cell, and 1 statement was in the low probability/low desirability cell. 44 items remained in

the "scattered" category.

A review of the data indicated that there was individual agreement on a significant number of items in the 50-66% range. These items were also placed in cells as outlined in Step 2 below.

Step 2. Using 50-66% as a level of agreement wherein each individual agreed on the probability and desirability of an item, items were placed in two cells on the matrix: 14 items were in the high probability/high desirability cell, and 6 statements were in the high probability/low desirability cell. 24 items remained in the "scattered" category.

A review of the 24 items remaining in the "scattered" category revealed that there was significant agreement on a number of items where over 50% of the total group rated an item in a similar way. These items were placed in categories as outlined in Step 3 below. When possible some of these items were then placed in the appropriate cells in a procedure similar to that used in Steps 1 and 2.

Step 3. Using an overall group response of 50% or greater the remaining 24 items were placed in six categories as outlined below.

Category 1: Overall group agreement in terms of probability/desirability. 3 items.

Category 2: Overall group agreement on desirability/no agreement on probability. 4 items.

Category 3: Overall group agreement on probability/no agreement on

desirability. 2 items.

Category 4: Overall group agreement on probability/undesirability. 3 items.

Category 5: Overall group agreement regarding undesirability/no agreement on probability. 7 items.

Category 6: "Scattered" items which did not fit into any of the categories above. 5 items.

Essentially the three steps outlined above provided two sources of information: (1) information contained on the matrix, and (2) the remaining categories identified in step 3. Using this information, items were selected for inclusion in the Round III questionnaire as follows:

The matrix was reviewed and matrix items treated in the following manner. There were 65 items in the cell for which there was significant agreement regarding probability and desirability. These 65 items, while important to the overall study, were dropped from Round III as not necessary for further exploration. There was 1 item for which there was significant agreement regarding low probability and undesirability. This item was dropped from Round III. There were 16 items for which there was significant agreement regarding probability and undesirability. These 16 items were included in Round III.

The categories identified in Step 3 were reviewed and treated in the following manner. Categories 1 and 4 had been placed on the matrix and had

already been dealt with. The 5 "scattered" items in category 6 were dropped from Round III. The 13 items remaining in categories 2, 3, and 5 were initially included in Round III.

In summary, data obtained regarding the probability and desirability of the hundred statements included in the Round II questionnaire were analyzed to provide information regarding participant rating of probability and desirability of the statements. This information, in addition to being important in itself, was used to sort the statements into categories suitable for further study in the Round III questionnaire.

Seventy-one items were dropped from the study. These items, and the rationale for dropping them are described further: 65 items were dropped on the basis of significant agreement regarding their probability and desirability, 1 item was dropped on the basis of agreement regarding low probability as well as low desirability, 5 items were dropped on the basis of insufficient agreement regarding either probability or desirability. The following 29 items, listed by category, were initially included in development of the Round III questionnaire: 16 items which were rated as probable but undesirable, 4 items which were rated desirable with little agreement regarding probability, 2 items which were rated probable with little agreement regarding desirability, 7 items which were rated undesirable with little agreement regarding probability.

Round III

Instrument Development. The Round III instrument (see Appendix F) consisted of a questionnaire containing twenty-four statements about the future which were grouped into four sections. There was also a fifth section where respondents were invited to make additional comments related to the study. The procedures used in developing the questionnaire are described below.

The initial Round III questionnaire was created from the twenty-nine statements derived from analysis of the Round III data. Each of the questionnaire items was similar in that the item began with a statement about the future and respondents were asked to identify the level(s) at which the statement was of greatest importance. The following levels were identified for each item: provincial, regional, system, school, and university; a space was also provided where respondents could specify other levels. Respondents who disagreed with any of the statements were also invited to state their reasons for doing so.

The twenty-nine statements in the questionnaire were also divided into four sections on the basis of criteria developed in analysis of the Round II data. The criteria at the beginning of each section and addtional questions, specific to each section, were asked. The four sections and specific questions are elaborated below:

Section 1. Round II statements regarded as highly probable as well as

highly undesirable. Respondents were asked to recommend strategies for reducing the probability of these statements. A total of sixteen items were included in this category.

Section 2. Round II statements regarded as highly desirable with little agreement regarding probability. Respondents were asked to recommend strategies for increasing the probability of these statements. A total of four items were included in this category.

Section 3. Round III statements regarded as highly probable with little agreement regarding desirability. There were two items in this category. Each item had specific questions related to the statement. Both items contained questions regarding the desirability of the statements.

Section 4. Round II statements regarded as highly undesirable with little agreement regarding probability. There were seven statements in this category. Respondents were asked to rate the level of concern for each of the statements as well as recommend potential strategies for reducing the probability of those developments.

In summary, the initial Round III questionnaire consisted of twenty-nine statements about the future divided into four sections on the basis of Round II participant rating of probability and desirability. There was also an additional section wherein participants were invited to make additional comments.

The first draft of the questionnaire contained twenty-nine statements about the future. This draft was reviewed by a doctoral student, a computer analyst,

and a study participant who had taken a great deal of interest in earlier rounds of the study. Concerns expressed were incorporated into a revision of the questionnaire. The only major concern was related to length and time for completion.

Primarily due to the length of the questionnaire, a complete section containing items which had been previously identified as undesirable with little agreement regarding probability, and viewed to be of least importance to the study, was initially dropped from the questionnaire. Two items from this dropped section, were later retained on the basis of interest.

The second questionnaire draft was reviewed by a doctoral student, a committee member, and the researcher's advisor. Apart from minor revisions, all agreed that the questionnaire was ready for dissemination.

Data Collection Procedures. All questionnaires were disseminated within a single day. Dissemination was accomplished in the following manner:

1. Three questionnaires were mailed.
2. Fifteen questionnaires were hand-delivered by the researcher. Of these fifteen questionnaires, five were given directly to the participants while the remaining eleven were left with secretaries or colleagues of participants.

Eight days after the questionnaires were distributed attempts were made to contact participants via telephone or in person. Within 18 days of initial

distribution 14 completed questionnaires had been picked up by the researcher. It took an additional 27 days for completion and pick-up of the remaining four questionnaires. This unusually long delay had been anticipated because of the Christmas season. The researcher kept in contact with the remaining four participants during this period. In summary, it took a total of 41 days from the time of initial distribution until final completion of the third round questionnaires. The participation rate was 100%.

Data Analysis. Methods of data analysis utilized in Round III were primarily qualitative. In addition to a frequency count an essential component of the data analysis involved summarizing the information collected and placing it in categories. The procedures utilized are described below as a series of steps:

Step 1. Responses from Part A (levels of concern) of each question were counted and totalled. Written responses were also noted.

Step 2. Using the original Round III questionnaire, which had been stored on a microcomputer word-processing program, a new file was created. Information from Step 1 as well as all of the recommended strategies in the written responses were entered under the appropriate questions.

Step 3. Each questionnaire item was answered separately. The written responses were categorized and summarized into

suggested strategies.

Step 4. The recommended strategies for all of the questions in section I and II were placed on a list. Identical items were removed from the list.

Step 5. A matrix was created from the recommended strategies list and the items in sections I and II of the questionnaire. A frequency count was done and the numbers tabulated (see Appendix G).

Step 6. Major recommended strategies were grouped and a frequency analysis done of each group. A percentage calculation was done and the strategies rank-ordered.

Step 7. Comments related to the four items in sections III and IV of the questionnaire were summarized.

In summary, information obtained from the Round III questionnaire was subject to the following procedures: Information regarding the level of concern for each questionnaire item was tabulated and a frequency count done. Information regarding strategies for dealing with the first twenty questionnaire statements, as well as comments regarding the remaining four statements, was also summarized and categorized. A matrix was then created. From the information on the matrix a second frequency count was done and the information rank ordered.

Major Features of the Study

The research design of the present study attempted to address a number of the concerns and criticisms related to the Delphi method, as previously discussed in Chapter 3. The major areas of concern, and strategies employed to address them, are described below:

1.) Consensus and convergence: the study did not strive for consensus. A clear distinction was made between probable futures and desirable futures.

2.) Reliance on a homogenous group of experts: the study panel consisted of individuals who, while knowledgeable about computers, represented a variety of interests and organizations.

3.) Panel selection: panel members were selected through an "expanding nucleus" technique.

4.) Panelist support: two-thirds of the panelists were nominated; prior to commencement of the study a check was done to insure that individuals would be available during the time-frame of the study; selective anonymity wherein participants knew the names of other participants but were guaranteed individual responses would remain anonymous; interviews were used in the first round to establish early "personal" contact; close personal contact was maintained throughout the study; attempts were made to reduce turnaround time.

5.) Time consuming: minimum turnaround time, most questionnaires were hand delivered and picked up; prompt reminders were given for late

responses.

Summary

This chapter has described the research design and procedures utilized in the study. The data for the study were collected through a pilot study and a three round Delphi. The study was designed to identify those changes in education which were both probable and possible through the introduction of computers as well as identify potential patterns for achieving a normative future. The Delphi study proceeded as follows:

In Round I participants were interviewed and asked to identify those developments, over the next five years, which were either probable or possible as a result of the continued introduction of computers to education. Data obtained in Round I were summarized and categorized into one-hundred statements about the future. These statements were included in a Round II questionnaire wherein participants were asked to rate the probability and desirability of each of the statements. Data obtained in Round II were categorized on the basis of participant ratings of probability and desirability. Seventy-six of the Round II statements, while important to the overall study, were dropped from Round III. The Round III questionnaire consisted of the remaining twenty-four statements about the future. In addition to recommending strategies for dealing with the first twenty Round III statements and making comments regarding the remaining four, participants were asked to

identify the organizational level for which each statement was of greatest concern.

Table 5.6 illustrates the method of data collection and number of participants in each round of the study.

Table 5.6

Method of Data Collection and Number of Participants

Round	Method of Data Collection	Number of Participants
Pilot study	Interview	6
Round I	Interview	18
Round II	Questionnaire	18
Round III	Questionnaire	18

Chapter 6

ANALYSIS OF DATA

As stated in earlier chapters, this study consisted of three phases: First, it 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. Second, it rated the desirability and overall probability of those changes identified as either probable or possible. Third, it identified potential patterns for achieving a normative future. These phases were dealt with sequentially in the three successive rounds of the study. This chapter presents the data analysis in a sequential manner from rounds one through three. It is divided in sections according to round. Each section includes the following: a statement of the purpose of the round; a brief description of the instrument; and, an analysis of the findings.

Round I

Purpose

The purpose of Round I was to identify those developments within education which were either plausible or for which there was potential as a

result of the continued introduction of computers to education. In identifying potential and plausible futures participants were asked to limit their comments to the next five years.

The Instrument

An interview was used as the instrument for data collection in Round I (see Appendix C). Participants were asked to identify the major plausible and potential futures possible as a result of the continued introduction of computers to education. They were asked to make specific comments related to the plausible and potential future in five areas related to education: (1) acquisition and funding; (2) courseware; (3) curriculum; (4) organizations; (5) teacher training. (A brief description was provided for each of the five areas, see Appendix C.) In addition to the five areas identified participants were asked to comment on any other areas they felt important to the study.

Prior to commencement of the interviews each participant was provided with three documents: (1) a letter describing the study; (2) a description of Round I of the study; (3) a copy of the interview schedule.

Analysis of the Findings

Data collected in the Round I interviews were summarized and categorized into one-hundred statements about the future. These statements are reported below under the following eight headings: acquisition and funding;

courseware/software; curriculum; teacher training; organizations; ethical concerns; equity; other areas.

Acquisition and Funding

1. Computer funding and support will increase at all levels.
2. Computers will be funded at the local level in a partnership arrangement involving the co-operation of a variety of organizations.
3. Provincial funding for educational computing will be determined through a complicated interplay of social, political, and economic forces.
4. In terms of funding for all of the areas related to computing, money for hardware will be the easiest to obtain.
5. A small number of schools will be designated to test prototypes of new hardware/software developments.
6. Computing equipment will continue to be housed in a variety of configurations and physical locations.
7. Schools will continue to acquire computing equipment at a rapid rate.
8. Subject areas and grade levels will compete for

placement of computing equipment.

9. Most of the newly acquired equipment will be placed in high schools.
10. Computers will be increasingly used to perform school administration functions.
11. Some individuals will perceive funding as being diverted from other needy areas in order to support computers.
12. Much of the newly acquired computing equipment will be underutilized.

Courseware/Software

1. Software will become part of an integrated instructional package (i.e. other items will be included such as cassettes, filmstrips, transparencies and print materials).
2. There will be an educational courseware/software development industry within the province.
3. The development of courseware suited for education will be a major problem.
4. A large amount of commercial educational courseware will be developed by individuals who do not have a background

in education.

5. There will be an evolution of authoring systems that allow teachers to develop their own programs.
6. There will be development of a local software industry tailored to provincial curriculum.
7. Educators will become more involved in courseware development teams.
8. More software will be developed for machines with large memory capacities.
9. The quality and quantity of software will continue to improve and increase.
10. Software will become increasingly user friendly.
11. The inertia of all the existing software will discourage upward capability of hardware.
12. A provincial agency, similar to a clearinghouse, will be involved in software evaluation and distribution.
13. Rights to software will be purchased at the provincial level and distributed to schools at reduced prices.
14. There will be an increased sharing of inter-provincial/ state information related to software evaluation.
15. Educators will continue to struggle with a definable set of criteria for courseware evaluation.

16. A large portion of software that is produced for the education market will be inappropriate for use in education.
17. Much of the software that is developed will support existing curriculum as well as existing approaches to instruction.

Curriculum

1. Computer technology will contribute to a re-examination of the whole curriculum area.
2. There will be a continuous discovery of new applications for computers in instruction.
3. Simulations will continue to be enhanced by c[redacted]uters.
4. Increased individualization of instruction, made possible through the use of computers, will conflict with homogenous grouping by grade level.
5. There will be more structure to what is taught in computer courses.
6. The use of LOGO as an instructional tool will increase in elementary classrooms.
7. Computers will contribute to a greater integration of subject matter.

8. Apart from the area of technology itself, curriculum content in other areas will remain much the same as it is at present.
9. Computers will be utilized to enable students to learn greater amounts of existing subject matter.
10. There will be less and less emphasis on teaching programming languages at the public school level.
11. Courses on computer literacy will not exist.
12. Word processing will change both physical and creative aspects of the way students write.
13. New computer languages will evolve and be taught at the school level.
14. The computer will present new opportunities for students with special needs.
15. Computers will contribute to more individualization of instruction.
16. Computer Assisted Instruction will become more prevalent.
17. Computer Managed Instruction will become more prevalent.
18. Computers will be used to teach repetitive activities that require mastery.

19. Computer technology will foster a move towards "gradelessness" where each student is able to proceed at their own rate.
20. Computers will increasingly be used as a tool of instruction to reinforce learning in a variety of subject areas.

Teacher Training

1. Prospective teachers will be able to get a degree with a specialty in computers.
2. Computer courses will become mandatory in preservice training.
3. A variety of educational organizations will be involved in delivering computer related continuing education programs.
4. Individual study will be the primary method of acquiring information about computers.
5. Computer related inservice will be compulsory for teachers.
6. Most graduates of the faculty of education will require computer related inservice.
7. There will be increased emphasis on courses in instructional psychology (i.e. the way people learn and

how computers can be used to improve instruction).

8. Inadequately prepared instructors and poorly designed courses, offered by a variety of institutions, will foster a negative attitude among teachers toward computers.
9. There will be more graduate courses related to computer applications.
10. Every new teacher, upon graduation, will have used computers in a variety of courses not directly related to computing.
11. Teachers will be adequately trained to deal with the social impact of computers.
12. While teachers will be consumers of computer technology they will use it in a way similar to the way they use textbooks in that they will not be directly involved in programming, evaluation, and distribution.
13. Computers will contribute to a change in the teacher's role from a disseminator of knowledge to a facilitator of learning.

Organizations

1. International technological competition will place an increased emphasis on computers in schools.

2. The development of technology will place increased expectations and demands on the education system.
3. Students with computers at home will make increasing demands on teachers.
4. With increased emphasis on computing the education system will become more dehumanized.
5. There will be increased public pressure for educational organizations to become more technologically oriented.
6. Computers will contribute to an increased pupil-teacher ratio.
7. Some of the elements of curriculum will be delivered off the school premises via computer technology.
8. In terms of improving quality of program offerings, computer technology will provide numerous opportunities for smaller rural schools.
9. The entire structure of educational organizations will be changed by the use of computers.
10. The use of computers will change the present classroom structure.
11. There will be a "grassroots movement" for computer related change.
12. There will be a "top-down movement" for computer

related change.

13. The introduction of computers will contribute to stress within all educational organizations.
14. Instructional consultants at the system level will become increasingly computer knowledgeable.
15. Despite the increased use of computers the role of teacher, student, and principal will remain primarily the same.
16. Computers will foster more parent involvement in the school.
17. Those interested in computers in education will develop "people networks" wherein information is shared more horizontally among organizations.
18. In relation to computers, external groups will continue to make conflicting demands on the educational community (i.e. the A.S.T.A., the A.T.A., the Home and School Assoc., the University, the Department of Education, Advanced Education).
19. Existing inertia or resistance to change will inhibit meaningful computer related changes in education.
20. Many talented, knowledgeable people in the area of computing will leave education.
21. The university will not be able to meet the demands

placed on it by a changing technological society.

22. Educational organizations, in using their resources to maintain existing systems, will have very little energy for future planning.

Ethical Concerns

1. The physical theft of hardware and software will continue to create problems.
2. Software piracy will continue to create problems.
3. We will have students breaking into all kinds of data bases.
4. Confidentiality of files and information will be a problem.

Equity

1. Many students without a public school background in computing will be seriously handicapped when they enter first year post-secondary courses.
2. Differential rates of adoption of computers will contribute to inequities in the education system and provide another example of the gap between the haves and the have nots.

3. Parents who are able to choose schools for their children will use quality of computer education programs as a criteria for selection.

Other Areas

1. New developments such as computer controlled laser disks and large monitors will be used in the classroom.
2. Educators will strive for increased hardware standardization.
3. Machines will become better, cheaper, faster.
4. "Take home" computers will be available for students to borrow from school.
5. New networks will appear at the school, system, provincial, and global level.
6. Strategic problems related to networking will be resolved.
7. The private sector will mount pressure on schools to train students in business related areas.
8. As the use of computers expands, and their advantages become more apparent, there will be an increased demand for the use of computers in education.
9. There will be a constant move towards an "ease of

human interface" for operating systems.

Summary of Round I

Round I utilized an interview to identify future developments which respondents reported to be either plausible or potential as a result of the continued introduction of computers to education. One hundred statements were identified and placed in the following divisions: acquisition and funding; courseware/software; curriculum; teacher training; organizations; ethical concerns; equity; and other areas. These statements were used in the development of the Round II questionnaire.

Round II

Purpose

The purpose of Round II was to rate the overall probability and desirability of the statements identified in Round I. Statements were placed in categories on the basis of participant rating of probability and desirability.

The Instrument

A questionnaire was used as the instrument for data collection in Round II (see Appendix D). The hundred statements identified in Round I were listed under eight separate divisions. Participants were required to rate the

probability and desirability of each of the statements. There was also a section where respondents were invited to make additional comments.

Analysis of the Findings

This sub-section first describes each of the categories into which Round I statements were placed on the basis of particpant rating of probability and desirability in Round II. It then reports the findings for each category.

Categories

The categories which were identified and the number of items which fell into each category are listed below:

Category 1: Overall group agreement in terms of probability/desirability. 65 items.

Category 2: Overall group agreement on desirability/no agreement on probability. 4 items.

Category 3: Overall group agreement on probability/no agreement on desirability. 2 items.

Category 4: Overall group agreement on probability/undesirability. 16 items.

Category 5: Overall group agreement regarding undesirability/no agreement on probability. 7 items.

Category 6: Overall group rating of improbable/undesirable. 1 item.

Category 7: "Scattered" items which did not fit into any of the categories above. 5 items.

The individual statements which fell into each of these categories are listed by category below. The level of agreement is also indicated.

The level of agreement was determined by using the following scale:

A 66-100% level of agreement wherein each individual agreed on the probability and desirability of an item= Very High Level.

A 50-66% level of agreement wherein each individual agreed on the probability and desirability of an item= High Level.

A level of agreement wherein over 50% of the total group rated an item in a similar way=Moderate Level.

The categories containing a large number of items also include the divisions into which statements were placed.

Category 1

Overall group agreement in terms of probability/desirabilty. 65 items:

A. Acquisition and Funding

Very high level of agreement

1. Computer funding and support will increase at all levels.
2. Computers will be funded at the local level in a partnership

arrangement involving the co-operation of a variety of organizations.

3. A small number of schools will be designated to test prototypes of new hardware/software developments.
4. Computing equipment will continue to be housed in a variety of configurations and physical locations.
5. Schools will continue to acquire computing equipment at a rapid rate.
6. Computers will be increasingly used to perform school administration functions.

High Level of Agreement

7. Provincial funding for educational computing will be determined through a complicated interplay of social, political, and economic forces.

B. Courseware/Software

Very High Level of Agreement

8. Software will become part of an integrated instructional package (i.e. other items will be included such as cassettes, filmstrips, transparencies and print materials).
9. There will be an evolution of authoring systems that allow teachers to develop their own programs.

10. Educators will become more involved in courseware development teams.
11. More software will be developed for machines with large memory capacities.
12. The quality and quantity of software will continue to improve and increase.
13. Software will become increasingly user friendly.
14. A provincial agency, similar to a clearinghouse, will be involved in software development and distribution.
15. Rights to software will be purchasd at the provincial level and distributed to schools at reduced prices.
16. There will be an increased sharing of inter-provincial/state information related to software evaluation.

High Level of Agreement

17. There will be an educational courseware/software development industry within the province.

C. Curriculum

Very High Level of Agreement

18. Computer technology will contribute to a re-examination of the whole curriculum area.

19. There will be a continuous discovery of new applications for computers in education.
20. Simulations will continue to be enhanced by computers.
21. There will be more structure to what is taught in computer courses.
22. The use of LOGO as an instructional tool will increase in elementary classrooms.
23. Computers will be utilized to enable students to learn greater amounts of existing subject matter.
24. Word processing will change both physical and creative aspects of the way students write.
25. The computer will present new opportunities for students with special needs.
26. Computers will contribute to more individualization of instruction.
27. Computer Assisted Instruction will become more prevalent.
28. Computer Managed Instruction will become more prevalent.
29. Computers will be used to teach repetitive activities that require mastery.
30. Computers will increasingly be used as a tool of instruction to reinforce learning in a variety of subject areas.

High Level of Agreement

31. Increased individualization of instruction, made possible through the use of computers, will conflict with homogenous grouping by grade level.
32. Computers will contribute to a greater integration of subject matter.
33. There will be less and less emphasis on teaching programming languages at the public school level.
34. New computer languages will evolve and be taught at the school level.
35. Computer technology will foster a move towards "gradelessness" where each student is able to proceed at their own rate.

D. Teacher Training

Very High Level of Agreement

36. Prospective teachers will be able to get a degree with a specialty in computers.
37. Computer courses will become mandatory in preservice training.
38. A variety of educational organizations will be involved in delivering computer related continuing education programs.

39. Most graduates of the faculty of education will require computer related inservice.

40. There will be more graduate courses related to computer applications.

41. Every new teacher, upon graduation, will have used computers in a variety of courses not directly related to computing.

42. Computers will contribute to a change in the teacher's role from a disseminator of knowledge to a facilitator of learning.

High Level of Agreement

43. There will be an increased emphasis on courses in instructional psychology (i.e. the way people learn and how computers can be used to improve instruction).

44. While teachers will become consumers of computer technology they will use it in a way similar to the way that they use textbooks in that they will not be directly involved in programming, evaluation, and distribution.

E. Organizations

Very High Level of Agreement

45. The development of technology will place increased expectations and demands on the education system.

46. Students with computers at home will make increasing

demands on teachers.

47. There will be increased public pressure for educational organizations to become more technologically oriented.
48. Some of the elements of curriculum will be delivered off the school premises via computer technology.
49. In terms of improving quality of program offerings, computer technology will provide numerous opportunities for smaller rural schools.
50. Instructional consultants at the system level will become increasingly computer knowledgeable.
51. Those interested in computers in education will develop "people networks" wherein information is shared more horizontally among organizations.

High Level of Agreement

52. International technological competition will place an increased emphasis on computers in schools.
53. The use of computers will change the present classroom structure.
54. There will be a "grassroots" movement for computer related change.

Moderate Level of Agreement

55. The entire structure of educational organizations will be changed by the use of computers.

F. Equity

Moderate Level of Agreement

56. Parents who are able to choose schools for their children will use quality of computer education programs as a criteria for selection.

G. Other Areas

Very High Level of Agreement

57. New developments such as computer controlled laser disks and large monitors will be used in the classroom.
58. Machines will become better, cheaper, faster.
59. New networks will appear at the school, system, provincial, and global level.
60. Strategic problems related to networking will be resolved.
61. As the use of computers expands, and their advantages become more apparent, there will be an increased demand for the use of computers in education.
62. There will be a constant move towards an "ease of human

interface" for operating systems.

Very High Level of Agreement

63. Educators will strive for increased hardware standardization.
64. "Take home" computers will be available for students to borrow from school.

Moderate Level of Agreement

65. The private sector will mount pressure on schools to train students in business related areas.

Category 2

Overall group agreement on desirability/no agreement on probability. 4 items:

Moderate Level of Agreement

1. There will be development of a local software industry tailored to provincial curriculum.
2. Computer related inservice will be compulsory for teachers.
3. Teachers will be adequately trained to deal with the social impact of computers.
4. Computers will foster more parent involvement in the school.

Category 3

Overall group agreement on probability/no agreement on

desirability. 2 items:

Moderate Level of Agreement

1. The introduction of computers will contribute to stress within all educational organizations.
2. Despite the increased use of computers the role of teacher, student and principal will remain primarily the same.

Category 4

Overall group agreement on probability/undesirability. 16 items:

Very High Level of Agreement

1. Much of the newly acquired computing equipment will be underutilized.
2. A large amount of commercial educational courseware will be developed by individuals who do not have a background in education.
3. A large portion of software that is produced for the education market will be inappropriate for use in education.
4. Software piracy will continue to create problems.
5. Confidentiality of files and information will be a problem.
6. Many students without a public school background in computing will be seriously handicapped when they enter first year post-secondary courses.

7. Differential rates of adoption of computers will contribute to inequities in the education system and provide another example of the gap between the haves and the have nots.

High Level of Agreement

8. In terms of funding for all of the areas related to computing, money for hardware will be the easiest to obtain.
9. Some individuals will perceive funding as being diverted from other needy areas in order to support computers.
10. The development of courseware suited to education will be a major problem.
11. Existing inertia or resistance to change will inhibit meaningful computer related changes in education.
12. Many talented, knowledgeable people in the area of computing will leave education.
13. The university will not be able to meet the demands placed on it by a changing technological society.

Moderate Level of Agreement

14. Subject areas and grade levels will compete for placement of computing equipment.
15. Most of the newly acquired equipment will be placed in high schools.
16. In relation to computers, external groups will continue to

make conflicting demands on the educational community (i.e. the A.S.T.A., the A.T.A., the Home and School Assoc., the University, the Department of Education, Advanced Education).

Category 5

Overall group agreement regarding undesirability/no agreement on probability. 7 items:

Moderate Level of Agreement

1. The inertia of all the existing software will discourage upward capability of hardware.
2. Apart from the area of technology itself, curriculum content in other areas will remain much the same as it is at present.
3. Computers will contribute to an increased pupil-teacher ratio.
4. There will be a "top-down" movement for computer related change.
5. Educational organizations, in using their resources to maintain existing systems, will have very little energy for future planning.
6. The physical theft of hardware and software will continue to create problems.
7. We will have students breaking into all kinds of data bases.

Category 6

Overall group rating of improbable/undesirable. 1 item:

Very High Level of Agreement

1. With increased emphasis on computing the education system will become more dehumanized.

Category 7

"Scattered" items which did not fit into any of the categories above. 5 items:

1. Educators will contine to struggle with a definable set of criteria for courseware evaluation.
2. Much of the software that is developed will support existing curriculum as well as existing approaches to instruction.
3. Courses on computer literacy will not exist.
4. Individual study will be the primary method of acquiring information about computers.
5. Inadequately prepared instructors and poorly designed courses, offered by a variety of institutions, will foster a negative attitude among teachers toward computers.

Summary of Round II

Round II utilized a questionnaire to determine the probability and

desirability of each of the statements about the future which had been identified in Round I. Round II statements were placed in seven categories on the basis of participant rating of probability and desirability. These categories were used in the development of the Round III questionnaire.

Round III

Purpose

The purpose of Round III was to identify potential patterns for achieving a normative future. Participants were asked to consider each of the twenty-four statements and identify the organizational levels for which the statement would be of greatest concern. Participants were also asked to recommend appropriate strategies for dealing with the first twenty statements as well as make comments regarding the remaining four.

The Instrument

A questionnaire was used as the instrument for data collection in Round III (see Appendix F). The questionnaire contained twenty-four statements divided into four sections on the basis of categories identified in Round II. There was also a section where respondents were invited to make additional comments about the study.

Analysis of Findings

The findings for Round III are reported in two stages. First, a summary of each questionnaire item is presented. Second, tables used in a final reduction of the data are presented.

Questionnaire Items

SECTION 1
ROUND II STATEMENTS REGARDED AS HIGHLY PROBABLE AS WELL AS HIGHLY UNDESIRABLE

1. Much of the newly acquired computing equipment will be underutilized.

   a. Of greatest concern at:
      8- provincial level 14- school level
      4- regional level 15- university level
      12- system level other level: i. Home-1

   b. Recommended strategies for reducing probability:

Strategy	Number of Recommendations
Inservice Training	11
Software/Courseware development	5
Preservice Training	4
Curriculum Development	4
Software/Courseware evaluation	3
Planning	2
Implementation	2
Policies for Re-allocation	2
School Based Budgeting	1
System Maintenance	1

   c. Disagree: 1

   d. Comments:
      "...they can be justified on the basis of the general literacy experiment for teachers and the district."

2. A large amount of commercial educational courseware will be developed by individuals who do not have a background in education.

   a. Of greatest concern at:

      11- provincial level 12- school level
      3- regional level 1- university level
      7- system level other level: i. home- 2
      ii. all levels- 1

   b. Recommended strategies for reducing probability:

Strategy	Number of Recommendations
Courseware Evaluation	6
Communicate Educational Criteria	6
More Educators Involved	6
Establish Educational Criteria	4
Provincial Development	4
Interprovincial Co-operation	1
Subsidize Recommended Courseware	1

   c. Disagree: 0

   d. Comments: 0

3. A large portion of software that is produced for the education market will be inappropriate for use in education.

   a. Of greatest concern at:

      13- provincial level 15- school level
      6- regional level 3- university level
      10- system level other level: 0

   b. Recommended strategies for reducing probability:

Strategy	Number of Recommendations
Courseware Evaluation	10
Provincial Development	5
Establish Educational Criteria	4
Interprovincial Co-operation	1
Inservice	1
Preservice	1
Communicate Educational Criteria	1
Pilot Testing	1

   c. Disagree: 0

   d. Comments: 0

4. Software piracy will continue to create problems.

   a. Of greatest concern at:

   10- provincial level 11- school level
   5- regional level 5- university level
   9- system level other level: i. commercial- 1
   ii. federal/provincial- 1

   b. Recommended strategies for reducing probability:

Strategy	Number of Recommendations
Special Pricing Agreements	5
Copyright Laws Clarified	5
Policy Guidelines	5
Emphasis on Ethics	2
Software Security	2
Reduced Prices	2
Litigation	1

   c. Disagree: 2

   d. Comments: 0

5. Confidentiality of files and information will be a problem.

   a. Of greatest concern at:
   10- provincial level
   6- regional level
   13- system level
   8- school level
   9- university level
   other level: i. business and gov't- 2
   ii. personal- 1

   b. Recommended strategies for reducing probability:

Strategy	Number of Recommendations
Security Procedures	7
Policies re: Access	5
Policies re: Information Stored	3
Emphasis on Ethics	1

   c. Disagee: 1

   d. Comments: 0

6. Many students without a public school background in computing will be seriously handicapped when they enter first year post-secondary courses.

   a. Of greatest concern at:
   6- provincial level
   1- regional level
   3- system level
   4- school level
   12- university level
   other level: i. post-secondary inst.- 1
   ii. individual students- 1

   b. Recommended strategies for reducing probability:

Strategy	Number of Recommendations
Curriculum Development	4
"Special" Entry Courses	4
Compulsory Courses	3
Preservice	1

   c. Disagree: 0

   d. Comments: 0

7. Differential rates of adoption of computers will contribute to inequities in the education system and provide another example of the gap between the haves and the have nots.

   a. Of greatest concern at:

   12- provincial level
   4- regional level
   8- system level
   11- school level
   4- university level
   other level: i. parents/students- 1
   ii. N.A.I.T./S.A.I.T.- 1

   b. Recommended strategies for reducing probability:

Strategy	Number of Recommendations
Funding (Designated)	8
Inservice (Expertise)	6
Set Minimum Standards	2
Policy Guidelines	1

   c. Disagree: 2

   d. Comments: 0

8. In terms of funding for all of the areas related to computing, money for hardware will be the easiest to obtain.
(Clarification: Some individuals perceive there to be inadequate funding for areas related to computing, i.e. facilities, courseware, staffing, maintenance.)

   a. Of greatest concern at:
      8- provincial level
      11- school level
      3- regional level
      2- university level
      12- system level
      other level: 0

   b. Recommended strategies for reducing probability:

Strategy	Number of Recommendations
Funding for Courseware and Facilities	5
Policies re: Usage	3
Funding re: Inservice	2
Board Allocations	1
School Allocations	1
Maintenance Support	1

   c. Disagree: 0

   d. Comments: 0

9. Some individuals will perceive funding as being diverted from other needy areas in order to support computers.

   a. Of greatest concern at:
      7- provincial level
      3- regional level
      13- system level
      16- school level
      4- university level
      other level: 0

   b. Recommended strategies for reducing probability:

Strategy	Number of Recommendations
Policy Guidelines	5
Curriculum Development	4
Inservice	2

   c. Disagree: 0

   d. Comments: 0

10. The development of courseware suited for education will be a major problem.

   a. Of greatest concern at: (check as many as necessary)
      12- provincial level
      9- regional level
      13- system level
      15- school level
      9- university level
      other level: i. home- 1

11. Existing inertia or resistance to change will inhibit meaningful computer related changes in education.
(Clarification: Most individuals interpreted meaningful change as an integration of computers into the curriculum.)

a. Of greatest concern at:

10- provincial level	14- school level
4- regional level	5- university level
11- system level	other level: 0

b. Recommended strategies for reducing probability:

Strategy	Number of Recommendations
Inservice	8
Funding	2
Planning	2
Implementation	2
Preservice	1
Software/Hardware Availability	1
Time and Experience	1

c. Disagree: 1

d. Comments: 0

12. Many talented, knowledgeable people in the area of computing will leave education. (Clarification: Individuals may leave for a variety of reasons, two of the most often cited were better opportunities and/or frustration within education.)

    a. Of greatest concern at:

6- provincial level	12- school level
4- regional level	8- university level
12- system level	other level: 0

    b. Recommended strategies for reducing probability:

Strategy	Number of Recommendations
Release Time	4
Pay Incentives	4
Recognition	3
Avoid Overloading	1

    c. Disagree: 2

    d. Comments: Three comments suggested that it was a "natural" occurence.

13. The university will not be able to meet the demands placed on it by a changing technological society. (Clarification: Many individuals commented that the university lacks the structure and resources to deal with a rapidly changing technological society.)

a. Of greatest concern at:

7- provincial level	3- school level
2- regional level	14- university level
3- system level	other level: 0

b. Recommended strategies for reducing probability:

Strategy	Number of Recommendations
Funding	9
Change Management Structure	4
Curriculum (Restructure)	3
Inservice	1
Remove Tenure	1
Industry Liaison	1

c. Disagree: 1

d. Comments: "University is at the forefront of new technology."

14. Subject areas and grade levels will compete for placement of computing equipment.

    a. Of greatest concern at:
    3- provincial level 14- school level
    2- regional level 4- university level
    7- system level other level: 1 (not specified)

    b. Recommended strategies for reducing probability:

Strategy	Number of Recommendations
Funding	3
Planning	3
Sharing Arrangements	2
Administrator Inservice	1

    c. Disagree: 1

    d. Comments: "A healthy sign."
    "O.K. Best users win."
    "Desirable."

15. Most of the newly acquired equipment will be placed in high schools. (Clarification: Many individuals felt that some of this equipment should be placed in other areas.)

    a. Of greatest concern at:
    5- provincial level 12- school level
    2- regional level 2- university level
    7- system level other level: 1 (not specified)

    b. Recommended strategies for reducing probability:

Strategy	Number of Recommendations
Funding (Change Formula)	9
Policies re: Equipment Migration	2
Inservice	1

    c. Disagree: 1

    d. Comments: "Acceptable as an initial thrust."

16. In relation to computers, external groups will continue to make conflicting demands on the educational community (i.e. the A.S.T.A., the A.T.A., the Home and School Assoc., the University, the Department of Education, Advanced Education).

    a. Of greatest concern at:

8- provincial level	10- school level
4- regional level	3- university level
9- system level	other level: 1 (not specified)

    b. Recommended strategies for reducing probability:

Strategy	Number of Recommendations
Communication	5

    c. Disagree: 1

    d. Comments: Five comments generally suggested that this conflict was "invevitable".

SECTION II
ROUND II STATEMENTS REGARDED AS HIGHLY DESIRABLE WITH LITTLE AGREEMENT REGARDING PROBABILITY

1. There will be development of a local software industry tailored to provincial curriculum.

   a. Of greatest concern at:
      12- provincial level
      1- regional level
      5- system level
      7- school level
      5- university level
      other level: 0

   b. Recommended strategies for increasing probability:

Strategy	Number of Recommendations
Funding	6
Industry Liaison	4
Provincial Involvement	3
Piracy Prevention	1
Planning	1

   c. Disagree: 1

   d. Comments:
      "Unlikely."
      "Not an issue-an economic issue."
      "Human talent is required-in most cases gov't would rather buy this talent than create it."

2. Computer related inservice will be compulsory for teachers.

   a. Of greatest concern at:

10- provincial level	12- school level
7- regional level	7- university level
13- system level	other level: 0

   b. Recommended strategies for increasing probability:

Strategy	Number of Recommendations
Funding	5
Mandatory Certification	3
Inservice	2
Release Time	1

   c. Disagree: 3

   d. Comments: 0

3. Teachers will be adequately trained to deal with the social impact of computers.

   a. Of greatest concern at:

      10- provincial level
      4- regional level
      8- system level
      7- school level
      9- university level
      other level: 0

   b. Recommended strategies for increasing probability:

Strategy	Number of Recommendations
• Inservice	5
Preservice	2
Curriculum Development	2

   c. Disagree: 1

   d. Comments:

      "The impact of artificial intelligence and 5th generation machines and their social implications is largely misunderstood by most of the educational community."

      "We will always be inadequately trained because of the rapidly changing nature of technology with which we deal. Our major effort should be directed toward including discussions related to these issues at teachers conferences and professional development activities."

4. Computers will foster more parent involvement in the school.

   a. Of greatest concern at:
      1- provincial level 12- school level
      2- regional level 0- university level
      4- system level other level: 0

   b. Recommended strategies for increasing probability:

Strategy	Number of Recommendations
Parent Classes	3
Communication	2
Parent Committees	2
Funding	1
Networking	1
Take-Home Courseware	1

   c. Disagree: 2

   d. Comments: Three comments suggested that the interest would not last.
   One respondent observed: "As long as the involvement is not only for fund raising."

SECTION III
ROUND II STATEMENTS REGARDED AS HIGHLY PROBABLE WITH LITTLE AGREEMENT REGARDING DESIRABILITY

1. The introduction of computers will contribute to stress within all educational organizations.

   a. Of greatest concern at:
      11- provincial level 14- school level
      8- regional level 12- university level
      14- system level other level: Homes- 1

   b. To what degree will computers contribute to dysfunctional stress within educational organizations? (Circle one)
      to a large degree 1 2 3 4 5 very little
      Responses: 2 6 2 2 6

   c. To what degree will computers contribute to stress within educational organizations that leads to positive changes?
      to a large degree 1 2 3 4 5 very little
      Responses: 4 8 2 2 1 (no response: 1)

   d. Summary of Additional comments:

      Three comments reinforced that there would be stress--two of these comments emphasized that this stress would lead to positive changes. Two other comments disagreed that stress would occur as a result of the introduction of computers.

      One comment emphasized that administrators would have to develop new skills for an information society.

      One comment suggested that the level of stress depended on how successful we were at implementing computer related policies while a further comment emphasized the need to articulate policy:

      > Stress arises from the need to articulate policy. The need for provincial and system level policy is great. P[illegible]ies will emerge and these will result in critical areas of educational computing being studied and plans for meeting needs being developed.

2. Despite the increased use of computers the role of teacher, student, and principal will remain primarily the same.

   a. Of greatest concern at:

8- provincial level	12- school level
6- regional level	4- university level
10- system level	other level: community- 1

   b. Summary of additional comments regarding the desirability of the above statement:

   Comments related to this statement reflected little agreement regarding the future role of teachers, students, and principals. Six comments agreed with the statement--two of these comments emphasized the need to maintain a human dimension in learning. Seven comments foresaw some form of role change--ranging from teachers and principals playing a more humanistic role to a greater emphasis on individualized learning.

   Two comments identified resistance to change as being a significant inhibitor to role changes.

SECTION IV
ROUND II STATEMENTS REGARDED AS HIGHLY UNDESIRABLE WITH LITTLE AGREEMENT REGARDING PROBABILITY

1. The inertia of all the existing software will discourage upward capability of hardware. (Clarification: Some individuals felt that resources already invested in existing software would discourage the purchase of any newer generation equipment that was incompatible.)

   a. Of greatest concern at: (check as many as necessary)

8- provincial level	13- school level
5- regional level	4- university level
9- system level	other level: 0

   b. A matter of:

   great co[illegible] 3 4 5 little concern
   Resp[illegible] 2 3. 3 (No response: 1)

   c. Summary of potential strategies for reducing probability of such a development:

      Eleven strategies were recommended for dealing with this problem. They are quoted below:

      Provincial leadership is needed in monitoring technological development and testing out promising new leads. Most school systems do not have the resources to do this themselves.

      Foster the fact that there will be continued change, and at a faster pace.

      Trade-up deals with software companies.

      It is the software that should be the focus--schools will buy hardware that is compatible.

      Periodic replacement of absolute equipment can be encouraged by a BQRP-type strategy.

      In some respect it may be a good thing not to replace equipment with the next generation as long as the present

equipment continues to serve the purpose for which it was intended. Wholesale upgrading is most unlikely in any event because of the huge cost involved.

We must accept replacement every 5 years or so as we have in automobiles.

Unfortunate, but true. However, sound planning will help alleviate this-e.g. Apple IIe runs most II+ software. This was a major concern in the setting of Alta. Ed's. hardware standard.

Schools should be ready to sell outdated computers as soon as a significantly improved computer is on the market. If they wait too long then they will lose ALL of this investment.

Amortization schedules.

Some funds must be allocated annually into a "slush fund" to ensure the availability of funds to acquire new hardware, much as we now do in terms of capital replacement.

2. Apart from the area of technology itself, curriculum content in other areas will remain much the same as it is at present.
   a. Of greatest concern at:

13- provincial level	12- school level
5- regional level	5- university level
8- system level	other level: 0

   b. A matter of:

great concern	1	2	3	4	5	little concern
Responses:	5	4	5	1	0	(no response: 2)

   c. Summary of potential strategies for reducing probability of such a development:

Eight comments were made related to strategies for dealing with this statement. They included: making technology a mandatory topic to be dealt with in every curricular area, orderly well-conceived change, a Task Force to examine the validity of what and how we teach, Department of Education commissioned curriculum development projects related to technology, designated funding for updating curricula, teacher inservice, integration of computers in other areas of curriculum, and curriculum revision.

Four comments stressed that curricular change would occur as part of a normal ongoing process. Most representative of this view was the following statement:

> Curriculum changes as culture and the disciplines change. If technology accelerates those changes, curriculum will also change. Technology will force changes in how children learn. What they learn depends upon many variables. I do not feel that changing the curriculum is warranted because technology has reared its ugly head, so to speak. Inevitably, the content of courses where technology plays a major role, must change. To change the program of studies and graduation requirements because of changing personal and societal needs is natural. This tends to occur more rapidly during periods of great technological change. Technology is the third variable and leads indirectly to curriculum reform.

SECTION V
ADDITIONAL COMMENTS

Comments made in this section were related to funding, the need for philosophical and sociological reflection, need for appropriate software, lack of an appropriate hardware migration path, the role of the university, planning, the role of government in software development, and rapid changes in technology.

One participant reported difficulty with a question. Two participants were complimentary of the overall study.

Representative comments include the following:

> Many of the strategies seem to hinge on funding, but money seems to be the key to whether educators "handle" advancing technology well or not.

> It has been suggested that the reason computers are "catching on" like this is because they divert attention from the growing number of problems in education. They represent a glimmer of positive potential in an otherwise gloomy environment. If all it takes is money to maintain and possibly enlarge this glimmer, then why not?

> Philosophical and societal barriers have not arisen to be wrestled with.

> I am concerned when the new BQRP Apple's are no longer what was hoped for. The disk drive technology is 1978 (IBM -A has 1.2 M 5.25") and the printing is marginal. There has yet to be announced a follow up product to give schools a clear UPWARD immigration path.

> Responses to many questions depend on whether the respondent sees government as an intervenor or an observer in the market. Conservative governments are uncomfortable in the former role. That feeling is being reinforced at the present time by monetary and budgetary policies. I see no great likelihood of major gov't expenditures in Advanced Education or Education to stimulate courseware production. Some other department might, as an economic strategy.

Free market forces have taken care of our learning resource needs for many years. Until it has been definitely shown that computers are sitting in storerooms unused because producers refuse to develop courseware without gov't financial incentives, I doubt that these producers will be treated differently from print and non print publishers.

As we know--effective software is the key to success in education. We can't judge the future of computers in education or the past as we are experiencing a quantum level change as we go from 8-32 bit processors. The implication of these hardware developments means the interface between people and machines will change fundamentally-eg. graphics, voice recognition, etc. Coupled with AI (Artificial Intelligence) developments we should see the "intelligent tutor" within 5-10 yrs. surpassing many teachers in knowledge about learning & in discerning strategies for instruction/remediation. In the long term this has enormous implications for the SYSTEM of education that has evolved since the industrial revolution.

Tables Used in Round III Data Analysis

This section includes three tables used in the analysis of Round III data. Table 6.1 and Table 6.2 present the recommended strategies rank-ordered by group. Table 6.3 presents the levels of greatest concern for each of the Round III statements. An additional table, "Matrix of Round III Items and Recommended Strategies, is included in Appendix G.

Table 6.1

Rank-Ordered Strategies by Percentage of Total Responses (Group 1)

Rank Order	Strategy Category	Number of Responses	Percentage of Total Response
1	Software/Courseware	73	22.87
2	Funding	61	19.03
3	Inservice	38	11.85
4	Policies	26	8.11
5	Curricular Development	17	5.30
6	Preservice	9	2.80
7	Planning	8	2.49
8	Security Procedures	7	2.18
9	Communication	7	2.18
	Sub Total	246	76.71

Table 6.2

Rank-Ordered Strategies by Percentage of Total Responses (Group 2)

Rank Order	Strategy Category	Number of Responses	Percentage of Total Response
10-14	Copyright Laws	5	1.56
	Industry Liaison	"	"
	Release Time	"	"
	Special Pricing Agrm.	"	"
	Parent Involvement	"	"
15-17	Change Management Struc.	4	1.24
	Implementation	"	"
	"Special" Entry Courses	"	"

Table 6.2 (continued)

Rank-Ordered Strategies by Percentage of Total Responses (Group 2)

Rank Order	Strategy Category	Number of Responses	Percentage of Total Response
18-22	Compulsory Courses	3	.93
	Emphasis on Ethics	"	"
	Interprovincial Co-op.	"	"
	Mandatory Certification	"	"
	Recognition	"	"
23-26	Reduced Prices	2	.62
	Set Minimum Standards	"	"
	Sharing Arrangements	"	"
	Software Security	"	"
27-40	Avoid Overloading	1	.31
	Board Allocations	"	"
	Litigation	"	"
	Maintenance Support	"	"
	Networking	"	"
	Pilot Testing	"	"
	Piracy Prevention	"	"
	Remove Tenure	"	"
	School Allocations	"	"
	School Based Budgeting	"	"
	Software/Hardware Avail.	"	"
	System Maintenance	"	"
	Take -Home Courseware	"	"
	Time and Experience	"	"
Sub Total (Table 1B)		74	22.99
Sub Total (Table 1A)		246	76.71
	Total	320	99.70

Table 6.3 presents the frequency count of the levels of greatest concern identified for each of the statements in the Round III questionnaire.

Table 6.3

Round III Statements: Level of Greatest Concern

QUESTIONNAIRE ITEMS	LEVEL OF GREATEST CONCERN					
	Prov	Region	System	School	Univ	Other
Section I						
1. Underutilization of equipment	8	4	12	14	15	1
2. Courseware development lacking educational input	11	3	7	12	1	3
3. Software inappropriate for education	13	6	10	15	3	0
4. Software piracy	10	5	9	11	5	2
5. Confidentiality of information	10	6	13	8	9	3
6. Lack of computing skills a handicap at post-secondary	6	1	3	4	12	3
7. Differential rates of adoption contributing to inequities	12	4	8	11	4	2
8. Continued funding for hardware	8	3	12	11	2	0
9. Computers diverting needed funds	7	3	13	16	4	0
10. Problem developing courseware	12	9	13	15	9	2
11. Resistance to change	10	4	11	14	5	0
12. Migration of talent	6	4	12	12	8	0
13. Increased demands on universities	7	2	3	3	14	0
14. Competition for equipment	3	2	7	14	4	1
15. High schools acquiring equipment	5	2	7	12	2	1
16. Conflicting demands on education	8	4	9	10	3	1
sub-total:	136	62	149	182	100	19
Section II						
1. Local software industry	12	1	5	7	5	0
2. Compulsory inservice	10	7	13	12	7	0
3. Teachers trained to deal with social impact of computers	10	4	8	7	9	0
4. Increased parent involvement	1	1	4	12	0	0
sub-total:	33	13	30	38	21	0
Section III						
1. Computers contributing to stress	11	8	14	14	12	1
2. Unchanged roles	8	6	10	12	4	1
sub-total:	19	14	24	26	16	2
Section IV						
1. Existing software reducing upward capability of hardware	8	5	9	13	4	0
2. Curriculum content unchanged	13	5	8	12	5	0
sub-total:	21	10	17	25	9	0
Total:	209	99	220	271	146	21

Summary of Round III

Round III utilized a questionnaire to identify potential patterns for achieving a normative future. A frequency analysis was done of the organizational levels of concern and recommended strategies were grouped and rank-ordered.

Summary

This chapter has provided a description of the data collected in the study. The three rounds of the study were presented sequentially. Each round included a statement of the purpose, a brief description of the instrument, and, an analysis of the findings.

Round I utilized a personal interview as the instrument for data collection to identify those developments in education which were both probable and possible, over the next five years, as a result of the continued introduction of computers. One hundred-statements about the future were identified. These statements were categorized under eight headings: acquisition and funding; courseware/software; curriculum; teacher training; organizations; ethical concerns; equity; and other areas.

Round II utilized a questionnaire to determine the overall probability and desirability of each of the statements about the future which had been identified

in Round I. Round II statements were placed in seven categories on the basis of participant rating of probability and desirability.

Round III utilized a questionnaire to identify potential patterns for achieving a normative future. Recommended strategies were grouped and rank-ordered.

Chapter 7

SUMMARY AND CONCLUSIONS

In this chapter the overall summary and conclusions of the study are presented. The first section provides a description of the problem, conceptual framework, and methodology utilized. Remaining sections provide a summary of the research findings as well as conclusions based on the findings.

Purpose, Conceptual Framework, and Methodology

Purpose of the Study

The purpose of the study was to identify those changes in education which were both probable and possible through the continued introduction of computers and identify potential patterns for achieving a normative future. Specifically, the following questions were asked:

1. What changes are both probable and possible in education within the next five years as a result of the influence of computers?
2. What is the desirability and overall probability of those changes identified as either probable or possible?
3. What are the potential patterns for arriving at a normative (desired) future?

The study also had as an additional purpose a further refinement of the Delphi methodology.

Conceptual Framework

The conceptual framework for this study was derived from aspects of the policy literature that relate to establishing policy alternatives. Nagel and Neef (1980:15) identified the study of alternative policies as an integral component of policy analysis and policy study while Dror (1971:70) stressed the importance of establishing alternative futures to serve as contexts for policymaking. The study dealt with first identifying alternative futures related to computer technology and education and then exploring policy alternatives for achieving a desired future. Dunn's (1981:143) discussion on identifying types of futures for forecasting policy alternatives provided much of the conceptual framework for the study. Essentially the study, using definitions provided by Dunn (ibid.), identified those futures that were plausible, potential, and normative and then explored strategies for arriving at a normative (desired) future.

Methodology

The Delphi

The methodology employed in this study was that of a Delphi, more specifically, it resembled that of Policy Delphi. A Delphi is an iterative

procedure which allows a group of individuals to collectively address complex problems. It is usually future oriented. An essential feature of a Policy Delphi is that, unlike Conventional Delphi studies, it is designed to explore policy issues and does not strive for consensus.

The study involved three distinct iterations or rounds. First, those changes in education which were either probable or possible within the next five years as a result of the continued influence of computers were identified. Second, a rating was obtained of the desirability and probability of those changes identified as either probable or possible. Third, potential patterns for achieving a normative (desired) future were explored.

The Delphi Panel

Critical to the success of Delphi studies is the Delphi panel. 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.

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.

Instruments and Data 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. They were designed to explore concerns related to the impact of computers on education and help conceptualize the problem to be explored in the major study. Information obtained in the pilot study was one of the sources of information 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. An interview was used as the instrument for data collection. The interview guide was developed from information obtained in the pilot study as well as the literature. Participants were asked to identify the major plausible and potential futures

possible as a result of the continued introduction of computers to education in each of the following 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 instrument.

The purpose of Round II was to rate the overall probability and desirability of statements identified in Round I. A questionnaire was used as the instrument for data collection. The questionnaire consisted of 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. There was also a section which invited additional comments. Each questionnaire item required two separate responses wherein the respondent had five choices for each response. Analysis procedures included reducing these five choices to three categories (a positive, uncertain, and negative rating) and recording the information with the use of a computer. 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. Seven categories were created from this information on the basis of participant rating of probability and desirability. These categories were used in the development of the Round III instrument.

The purpose of Round III was to identify potential patterns for achieving a normative (desired) future. A questionnaire, consisting of twenty-four statements about the future, was used as the instrument for data collection. Participants were asked to consider each of the statements and identify the organizational levels for which the statement would be of greatest concern. Participants were also asked to recommend strategies for dealing with the first twenty statements as well as make comments regarding the remaining four. Data collected was analyzed through a seven step procedure which included categorizing, summarizing, and frequency analysis.

The findings for each of the three rounds of the study are summarized separately below.

Findings of the Study

Findings of the study are grouped in four categories: those developments which were rated as probable and desirable; those developments which were rated as probable and undesirable; those developments which were rated as desirable with little agreement regarding probability; and, potential patterns for arriving at a normative future. Each of these categories is described further

under a separate heading.

Developments Which Were Rated as Probable and Desirable

Analysis of Round I and II data identified a number of changes that are both probable and desirable. These developments are reported under the headings of: Acquisition and Funding, Courseware/Software, Curriculum, Teacher Training, Organizations, and, Other Areas.

Acquisition and Funding

Increased funding and support for computers, at all levels, will ensure that schools will continue to acquire computers at a rapid rate. Funding for computers at the local level will continue to involve the co-operation of a variety of organizations while provincial funding will be determined through a complicated interplay of social, political and economic forces.

Computing equipment will continue to be housed in a variety of configurations and physical locations within schools. They will also be increasingly used to perform school administration functions.

A small number of schools will be designated to test prototypes of new hardware/software developments.

Courseware/Software

Findings regarding developments in the area of courseware/software are

summarized under three sub-categories: format, development, and distribution.

Format. The quality and quantity of software will both continue to improve and increase. Much of the new software will be developed for machines with larger memory capacities. It will become increasingly user friendly. It will also increasingly become part of an integrated instructional package including such items as cassettes, filmstrips, transparencies and print materials.

Development. Educators will become more involved in courseware development teams. There will be an evolution of authoring systems that allow teachers to develop their own programs. There will be an educational courseware/software development industry within the province.

Distribution. A provincial agency, similar to a clearinghouse, will be involved in software development and distribution. Rights to software will be purchased at the provincial level and distributed to schools at reduced prices. There will be an increased sharing of inter-provincial/state information related to software evaluation.

Curriculum

Findings regarding developments in the area of curriculum are summarized under three sub-categories: applications, re-examination of

curriculum, and, computer courses.

Applications. There will be a continuous discovery of new applications for computers in education. They will increasingly be used to reinforce learning in a variety of subject areas. This use will foster further developments in areas such as special education, individualized instruction, simulations, LOGO, Computer Assisted Instruction, and, Computer Managed Instruction.

Re-examination of curriculum. Computer technology will contribute to a re-examination of the whole curriculum area. For example the following developments will contribute to this re-examination:

1. Computers will be utilized to enable students to learn greater amounts of existing subject matter.
2. Increased individualized instruction will conflict with homogenous grouping by grade level and foster a move towards "gradelessness" where each student is able to proceed at their own rate.
3. Computers will contribute to a greater integration of subject matter.
4. Word processing will change both physical and creative aspects of the way students write.
5. Computers will be used to teach repetitive activities that require mastery.

Computer courses. In relation to computer courses there will be more structure to what is taught. While new languages will evolve and be taught at the school level, overall, there will be less emphasis on teaching programming languages relative to other activities.

Teacher Training

Findings regarding developments in the area of teacher training are summarized under three sub-categories: teacher's role, university, and inservice.

Teacher's role. Computers will contribute to a change in the teacher's role from a disseminator of knowledge to a facilitator of learning. There was also a high level of agreement that while many teachers will become consumers of computer technology they will use it in a way similar to the way that they use textbooks in that they will not be directly involved in programming, evaluation, and distribution of software materials.

University. Major developments predicted in relation to university training were:

1. Prospective teachers will be able to get a degree with a specialty in computers.

2. Computer courses will become mandatory in preservice training.
3. Every new teacher, upon graduation will have used computers in a variety of courses not directly related to computing.
4. There will be more graduate courses related to computer applications.
5. There will be an increased emphasis on courses in instructional psychology (i.e. the way people learn and how computers can be used to improve instruction).

Inservice. Findings related to inservice were:

1. Most graduates of the faculty of education will require computer related inservice.
2. A variety of educational organizations will be involved in delivering computer related continuing education programs.

Organizations

Findings regarding developments in the area of organizations are summarized under two sub-categories: pressure to change and changes.

Pressure to change. Educational organizations will feel pressure to change from a variety of areas, those developments identified were:

1. As the use of computers expands, and their advantages become more

apparent, there will be an increased demand for their use in education.

2. The development of technology will place increased expectations and demands on the education system.
3. International technological competition will place increased emphasis on computers in schools.
4. The private sector will mount pressure on schools to train students in business related areas.
5. Parents who are able to choose schools for their children will use quality of computer education programs as a criteria for selection.
6. Students with computers at home will make increasing demands on teachers.
7. There will be increased public pressure for educational organizations to become more technologically oriented.

Changes. There was a "moderate" level of agreement regarding computers changing the entire structure of educational organizations and a "high" level of agreement regarding computers changing the present classroom structure. There was a "very high" level of agreement regarding the following:

1. Some of the elements of the curriculum will be delivered off the school premises via computer technology.
2. In terms of improving quality of program offerings, computer technology will provide numerous opportunities for smaller rural schools.

3. Instructional consultants at the system level will become increasingly computer knowledgeable.
4. Those interested in computers in education will develop "people networks" wherein information is shared more horizontally among organizations.

Other Areas

While the study did not have technological change as its primary focus, several technological predictions were dealt with under this section:

1. Machines will become better, cheaper, faster.
2. New developments such as computer controlled laser disks and large monitors will be used in the classroom.
3. Strategic problems related to networking will be resolved.
4. New networks will appear at the school, system, provincial, and global level.
5. There will be a constant move towards an "ease of human interface" for operating systems.
6. "Take Home" computers will be available for students to borrow from school.

In summary, respondents identified a wide variety of computer related developments in education which were regarded as both probable and desirable. While some of these developments may be described as a reaction

to technological change the majority are perhaps best described as part of a continued "technological experiment".

Developments Which Were Rated as Probable and Undesirable

There were sixteen developments which respondents rated as both probable and undesirable. These developments are reported below:

1. Much of the newly acquired computing equipment will be underutilized.
2. A large amount of commercial educational courseware will be developed by individuals who do not have a background in education.
3. A large portion of software that is produced for the education market will be inappropriate for use in education.
4. Software piracy will continue to create problems.
5. Confidentiality of files and information will be a problem.
6. Many students without a public school background in computing will be seriously handicapped when they enter first year post-secondary courses.
7. Differential rates of adoption of computers will contribute to inequities in the education system and provide another example of the gap between the haves and the have nots.
8. In terms of funding for all of the areas related to computing, money for hardware will be the easiest to obtain.

9. Some individuals will perceive funding as being diverted from other needy areas in order to support computers.
10. The development of courseware suited for education will be a major problem.
11. Existing inertia or resistance to change will inhibit meaningful computer related changes in education.
12. Many talented, knowledgeable people in the area of computing will leave education.
13. The university will not be able to meet the demands placed on it by a changing technological society.
14. Subject areas and grade levels will compete for placement of computing equipment.
15. Most of the newly acquired equipment will be placed in high schools.
16. In relation to computers, external groups will continue to make conflicting demands on the educational community (i.e. the A.S.T.A., the A.T.A., the Home and School Assoc., the University, the Department of Education, Advanced Education).

Developments Which Were Rated as Desirable With Little Agreement Regarding Probability

There were four developments which respondents rated as desirable with

little agreement regarding probability. These developments were:

1. There will be development of a local software industry tailored to provincial curriculum.
2. Computer related inservice will be compulsory for teachers.
3. Teachers will be adequately trained to deal with the social impact of computers.
4. Computers will foster more parent involvement in the school.

Potential Patterns for Achieving a Normative Future

Round III identified potential patterns for arriving at a normative future. Responses were categorized and summarized into 40 strategies. Over three-quarters of the total number of responses were represented by just nine strategies. These nine strategies, in rank-order according to number of responses, were related to: software/courseware, funding, inservice, policies, curricular development, preservice, planning, security procedures, and, communication. These major strategies are described below. The thirty-one remaining strategies are also listed. Included in this section is a discussion of the levels of concern for considering potential patterns for arriving at a normative future.

Software/Courseware

A number of strategies were recommended for dealing with problems

related to software/courseware:

Evaluation was the most often cited strategy for improving the quality of software/courseware both used in, and developed for, education. In addition to evaluation, the establishment and communication of educational criteria was often recommended.

Two further strategies were recommended for improving the suitability of courseware/software for education: provincial involvement in development, and having more educators involved in this development--especially as members of development teams.

Increased software development was also suggested as a strategy for encouraging the proper utilization of equipment.

Funding

Funding was also viewed as being of importance in a number of areas:

-developing courseware suited for education

-promoting change

-helping universities meet the demands placed on it by a changing technological society

- ensuring that grade levels (other than high school) receive computing equipment

- providing support for areas other than hardware

- promoting development of a software industry

- properly rewarding those who make contributions to education
- subsidizing recommended courseware.

Designated funding was also recommended as alleviating some of the inequities that may occur in the education system as a result of the introduction of computers.

Inservice

Inservice training was viewed as being important in the following areas:

- the proper utilization of computing equipment
- diminishing the resistance to change that might inhibit meaningful computer related changes in education
- alleviating inequities in the education system
- training teachers to deal with the social impact of computers
- obtaining support for computer funding
- aiding teachers in software selection
- aiding administrators in equipment allocation.

Policies

Strategies related to policy were recommended in a variety of areas:

Policy guidelines were viewed as important for dealing with software piracy, allocation of funding, and promoting equity. Policies regarding access, and information stored, were viewed as important for dealing with

confidentiality of files. Polices regarding equipment migration were viewed as important for dealing with equipment allocation. Policy guidelines regarding usage were also viewed as important in dealing with problems related to acquisition of computer related materials.

Curricular Development

Curricular development at the public school level was recommended for:

- fostering the proper utilization of equipment
- providing all students with an opportunity for a public school background in computing
- encouraging support for computer related funding.

Curriculum restructuring was also recommended as a means for helping the university meet demands placed on it by a changing technological society.

Preservice

Preservice was recommended primarily as a means of encouraging the proper utilization of equipment.

Planning

Planning was viewed primarily as a means of:

-encouraging the proper utilization of equipment

-accommodating resistance to change

-eliminating competition for computing equipment.

Security Procedures

Addressing the problem of security through clearly established procedures was viewed as necessary for maintaining confidentiality of files and information.

Communication

Communication regarding computer related matters, both intra-organizational as well as with the stakeholders of the various organizations, was viewed as important.

Summary of Recommendations for Achieving a Normative Future

Potential strategies for achieving a more normative future are summarized on the following pages, in rank order, according to the number of recommendations received. The first nine strategies, which encompassed over three-quarters of the total number of recommendations, are listed first. In addition, the remaining thirty-one strategies, which encompassed less than one-quarter of the total number of recommendations, are also listed.

Rank Order	Strategy Category
1	Software/Courseware
2	Funding
3	Inservice
4	Policies
5	Curricular Development
6	Preservice
7	Planning
8	Security Procedures
9	Communication

Rank Order	Strategy Category
10-14	Copyright Laws
	Industry Liaison
	Release Time
	Special Pricing Agrm.
	Parent Involvement

Rank Order	Strategy Category
15-17	Change Management Struc.
	Implementation
	"Special" Entry Courses

Rank Order	Strategy Category
18-22	Compulsory Courses
	Emphasis on Ethics
	Interprovincial Co-op.
	Mandatory Certification
	Recognition

Rank Order	Strategy Category
23-26	Reduced Prices
	Set Minimum Standard
	Sharing Arrangements
	Software Security

Rank Order	Strategy Category
27-40	Avoid Overloading
	Board Allocations
	Litigation
	Maintenance Support
	Networking
	Pilot Testing
	Piracy Prevention
	Remove Tenure
	School Allocations
	School Based Budgeting
	Software/Hardware Avail.
	System Maintenance
	Take-Home Courseware
	Time and Experience

Levels of Concern

Participants viewed the following organizational levels, presented in rank-order, as being the greatest level of concern in terms of potential patterns for arriving at a normative future: the school, the system, the province, university, and region. Each of these areas was seen as being most involved in their traditional roles. For example, the system level was viewed as playing the greatest role in matters related to confidentiality of information and files, funding, staffing and inservice, while the province was viewed as having the greatest role in matters related to equity, development of a local software industry, teacher training, and curriculum. Two areas of significance were the generally high overall rating the school level received and the low rating received by regional levels.

Conclusions

The following conclusions, regarding developments in computer technology and education within the next five years, are based on the findings of the study:

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

2. There will be a continued commitment to computer technology. Computer related activities will continue 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.

3. A commitment to computer technology is a commitment to change. Technological change is inevitable. A commitment to technology in education is a commitment to ongoing change. Change will occur as an ongoing continuous process. The statement "change is a process, not an event" (Fullan, 1985:2) is particularly relevant to computer technology and education. Rapid

technological developments will further compound problems related to change in education. All educational organizations will experience changes precipitated by computer technology.

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.

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.

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.

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.

8. The Delphi provides useful information for futures oriented planning and policymaking. Given the rapid changes precipitated by technology, methodologies such as the Delphi can provide particularly useful information to educational policymakers.

9. 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: underutilization of equipment, 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.

10. 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.

Summary

This chapter provided an overall summary of the study as well as a presentation of the conclusions which emanate from the findings. The first section provided a description of the problem, conceptual framework, and methodology utilized. A summary of the findings was also provided. Finally, conclusions based on the findings were presented. The following final chapter presents a further discussion of the implications of these conclusions.

Chapter 8

IMPLICATIONS AND RECOMMENDATIONS FOR FURTHER STUDY

In this chapter a discussion of the implications of the study findings as well as recommendations for further research are presented. Implications are discussed under headings derived from conclusions presented in the previous chapter. The first section discusses the implications of conclusions one through eight. The second section, devoted to the remaining two conclusions, provides a discussion of the major issues that policymakers should address as well as potential patterns for consideration when addressing the impact of technology. The third section presents recommendations for further research.

Implications

From the literature review and conclusions of the study emerge the following implications:

1. Computer technology will have both positive and negative effects on education. While there are many benefits to be gained from using computers in education, exploiting the potential of computers will also create negative outcomes. In addition to identifying benefits this study identifies a number of negative outcomes. A critical role for policymakers is to ask questions related

to the negative effects of computer technology. Uhlig (1983:4) presents this question on a broad level: "What will be the negative side effects of an information-based society?" Viewing computers as a panacea for all that ails education has the potential to do much harm. 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. 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) indicate 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. 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 likely 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 transparent, 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. A commitment to technology is a commitment to change. Computer technology will foster many changes in education, not all of which will be positive. 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. The statement "change is a process, not an event" (Fullan,1985:2) 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." Developing strategies to deal with change presents a mammoth challenge as technological changes occur with increased rapidity. 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. 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". 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) observe: "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 is a clearer philosophy of technology (Burch 1984:13; Feibleman, 1982:16). Feibleman (ibid.) describes this philosophy as recognizing the inevitiablility of change and being a ". . . partially-ordered and permanently open system because knowledge from the experimental physical sciences continues to increase exponentially."

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, 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. 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. 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 would 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 computer related activity on the basis of a general technological experiment. A second implication of this conclusion is that through the assimilation of technology organizations may be avoiding meaningful changes (Sheingold et al., 1983:431).

Also, somewhat related to this conclusion, is the ongoing problem of coping with the myth and the reality of computer technology. First, expectations often far exceed the reality of what the technology can deliver. Second, there is no guarantee that the pedagogical applications which are possible in theory will automatically find their way to educational practice without adequate consideration for the realities of the change process. 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. 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 the study as well as Sheingold et al. (1983:427) identify computer technology as contributing to role overload among teachers. Certainly some of the recommended strategies for dealing with the innovation in the area of increased preservice and inservice will contribute to this overload. 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. Further policies regarding the use of computers in education will be developed both through action and inaction. For example, decisions will be made at the classroom, school, system, regional and provincial levels which affect how computers are used, who uses them, what courses are offered, equipment allocation, equipment configuration, and funding. While overall policies regarding the use of computers are necessary, it is also of critical importance that policymakers recognize the importance of the institutional setting of the school. 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 on how policy development be approached: ". . . 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. The Delphi provides useful information for futures oriented planning and Policymaking. There are advantages as well as disadvantages to conducting a Delphi. One of the purposes of the present 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.

9. Major issues and problems that policymakers will have to address and their implications.

A. Underutilization of equipment. 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., 1984:31). Increased teacher training activities at both the preservice and inservice levels could be viewed as attempts to deal with this problem. (Also, further contributing to the problem is lack of appropriate courseware/software.) However, 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. Allocation of equipment. 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. Lack of appropriate courseware/software. Both the findings of the study and 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. Piracy. 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. Confidentiality of files and information. The increased reliance on computers, especially in tasks related to administration, will create problems related to confidentiality. 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. Equity. 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.:ii) 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. Funding. 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. Resistance to change. 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. Computer technology creating its own resistance to change. Continued new developments in technology will make further change inevitable. Ironically, 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. Migration of human resources. 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. Increased and conflicting demands on educational organizations. 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.

10. Major potential patterns or strategies for policymakers to consider when dealing with the impact of computer technology.

A. Increased courseware/software development and evaluation. Continued and increased evaluation of programs presently being marketed for use in education was recommended as aiding educators in selecting appropriate materials. Also the establishment of educational criteria for courseware/software and the communication of this criteria to potential developers was recommended as improving the quality of materials being marketed. In addition, further involvement at the provincial level in terms of stimulating courseware development was also recommended. Having more educators involved as members of courseware/software development teams was recommended as improving the educational content of available materials.

B. Increased levels of funding. Much of the present funding has been allocated for computer acquisition. Realizing the potential of computers requires a significant amount of funding in other areas particularly the following: courseware development and acquisition, helping organizations implement computer related changes, equipment allocation, support for areas such as curriculum and teacher training, and properly rewarding those who make a significant contribution to education.

C. Inservice. Much of the benefits to be realized through the use of computer technology depend on proper inservice. This training was recommended for addressing problems related to: the proper utilization of computing equipment, dealing with resistance to change, alleviating inequities in the educational system, training teachers to deal with the social impact of computers, obtaining support for computer funding, aiding teachers in software selection, and aiding administrators in equipment allocation. The constant changes in education, precipitated to a large extent by computer technology, require inservice programs that are ongoing.

D. A recognition of the need for policies related to educational computing. To date major policy initiatives related to computers in education have been directed at acquisition. Policymakers must recognize the need for further policies, particularly in dealing with the following problems: software piracy, allocation of funding, equity, access to information, types of information stored, equipment migration and usage, and acquisition of computer related materials. These policies should recognize the critical significance of the school as an institutional setting (Berman and McLaughlin (1976:347).

E. Curricular development. If computers allow students to learn greater amounts of subject matter as well as new approaches to learning, such as individualized instruction, then new curricula that recognize and utilize the

power of the computer are required. These curricula would allow students to not only to think about computers, but with them. Such curricula would challenge some of our long held assumptions about the organization and dissemination of knowledge.

F. Preservice. Revised preservice programs were recommended. These programs would reflect the new demands placed on teachers by a changing technology.

Appropriate preservice, while critical to realizing the potential of computer technology, rated relatively lower than other recommended patterns. A possible interpretation of this rating is that, if this technology truly portends ongoing change, other strategies such as appropriate courseware/software development, inservice, and curricular development will play a more cruc[redacted] role.

G. Planning. Planning was recommended as a means of adapting to the changes brought about by technolology. It was recommended primarily as a means of encouraging proper utilization of equipment, adapting to change, and eliminating competition for computing equipment. Rapid change, precipitated largely by technology, makes increased planning an essential activity of educational organizations. Establishing appropriate goals through planning is critical to realizing the potential of computer technology. The technology will

only be as good as the goals we set for it.

H. Security procedures. Security procedures were recommended as necessary for maintaining confidentiality of files and information. Increased activity in the areas of information storage and transfer will increasingly present security problems for policy makers to address.

I. Communication. Conflicting and escalating demands will continue to be placed on educational organizations. Increased communication, both intra-organizational and amongst stakeholders of educational organizations, will be required.

Recommendations for Further Research

As a result of the literature review and the findings of this study, a number of recommendations for further research can be made.

Studies should be conducted which replicate the present study on an ongoing basis. As all research studies are timebound, a major advantage of conducting an ongoing Policy Delphi is that with the passing of time further insights would be gained as new developments occur. Additional insights could also be gained through varying participation in the panel.

Studies should be conducted which further explore the negative effects of technology on education. Increased knowledge of these effects would allow a

more appropriate use of computer technology.

Studies should be conducted which explore the interrelationships of the various developments identified in the present study. For example, a cross-impact analysis would be a natural extension of the present study.

The present study identified a number of potential patterns or strategies for dealing with the impact of computer technology. Studies which assess the feasibility of these alternatives should be conducted.

Studies should be conducted which address the research areas identified in the Minister's Task Force (1983:98), specifically: ". . . the effects of computing on the learning process, the role of teachers, and the organizational structure of schools, the mental and physical effects of computer use on students, and the implications of computers to social attitudes and relationships."

The widespread experimental use of computers in education will continue. Studies should be conducted which identify those endeavours that have positive outcomes.

Studies which examine basic curriculum questions should be conducted. These studies would focus on questions related to appropriate ways of organizing and disseminating knowledge. The rapid and ever increasing changes in technology and society dictate that these questions be addressed on an ongoing basis.

Studies should be conducted which examine those values of lasting worth to education and which incorporate a more philosophical reflection of

technological change.

Studies should be conducted which further examine the forces for technological related changes in education. Such studies would examine the roles of stakeholders such as children, parents, teachers, administrators, politicians, vendors, and industry. A basic question which should also be asked is: Who benefits from the change?

Summary

This final chapter provided a discussion of the implications of the study findings. Implications of the following conclusions were presented: (1) Computer technology having both positive and negative effects; (2) A continued commitment to computer technology; (3) A commitment to change; (4) Computer technology providing the impetus to ask basic pedagogical questions related to curriculum and teacher training; (5) Changes related to computer technology being external to the learning process; (6) Increased demands on teachers; (7) All educational organizations being required to make decisions and establish policies related to computer technology; (8) The Delphi providing information which is useful in futures oriented planning and policymaking. A discussion of the remaining two conclusions, related to the major issues that policymakers should address as well as potential patterns for consideration when addressing the impact of technology, were also presented. Major issues discussed were: underutilization of equipment, 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. Potential patterns for consideration which were presented included: 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.

Finally, some suggestions for further research were presented.

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APPENDICES

APPENDIX A

PARTICIPANTS IN THE PILOT STUDY

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Mrs. G. Cathcart	-Teacher, Edmonton Public
Dr. S. Hunka	-Director of Educational Research Services, U of A
Dr. G. Romaniuk	-Associate Chairman, Department of Educational Psychology, U of A
Mr. C. Roxburgh	-Associate Director, In-Service Manager, Computer Technology Project, Alberta Education
Dr. J. Thiessen	-Director Computer Technology Project Alberta Education Edmonton, Alberta

APPENDIX B

PARTICIPANTS IN THE THREE ROUND DELPHI STUDY

Participants in the Three Round Delphi Study

Mrs. J. Bererton	-Teacher, Edmonton Public
Dr. G. Bevan	-Director of Curriculum Branch, Alberta Education
Dr. T. Blowers	-Director Program Review, Research Liaison, Edmonton Public
Mrs. G. Cathcart	-Teacher, Edmonton Public
Mr. A. Donovan	-Education Specialist, Apple Canada
Mr. N. Fedirka	-Principal, Leduc County
Dr. S. Hunka	-Director of Educational Research Services, U of A
Mr. G. Kozak	-Computer Literacy Consultant, Edmonton Separate
Dr. M. Petruk	-Professor of Education, U of A
Mr. B. Pitzel	-Teacher, Vice-Principal, Leduc County
Mr. R. Schienbein	-Executive Assistant, Strathcona County
Ms. P. Redhead	-Consultant, Microcomputer Services, Edmonton Public
Dr. G. Romaniuk	-Associate Chairman, Department of Educational Psychology, U of A
Mr. C. Roxburgh	-Associate Director, In-Service Manager, Computer Technology Project, Alberta Education
Dr. J. Thiessen	-Vice-President Research and Development, Novachem Laboratories Ltd.
Mr. J. Travers	-Learning Systems Branch, Advanced Education
Mr. D. Wighton	-Clearinghouse Manager, Alberta Education
Dr. P. Wright	-Manager Distributed Systems Team, Information Services, Edmonton Public

APPENDIX C

ROUND I PACKAGE OF MATERIALS

FACULTY OF EDUCATION
DEPARTMENT OF EDUCATIONAL ADMINISTRATION

THE UNIVERSITY OF ALBERTA
EDMONTON, CANADA
T6G 2G5

August, 1984

Dear

Thank you for agreeing to participate in this study on computer technology and education. The study hopes to identify those changes in education which are either probable or possible through the continued introduction of computers. In addition, it will explore potential strategies for implementing those changes which have been deemed desirable by respondents.

The study will utilize a modified Delphi technique to gather information. Briefly, the Delphi is a method of structuring group communication so that a group of people can deal with a complex problem. The Delphi study you are participating in will involve three rounds. Round I will consist of an interview while Rounds II and III will consist of questionnaires.

Data collected in the study will be used in a thesis being completed in partial fulfilment of a doctoral degree in educational administration. Individual responses will be kept anonymous. You will be presented with a summary document of the findings at the conclusion of the study.

If you should wish to discuss any aspect of the study with me I can be reached at 432-3094 (days) or 435-5928 (evenings).

Sincerely

Lloyd P. Steier
Doctoral Candidate

COMPUTER TECHNOLOGY AND EDUCATION

ROUND I INTERVIEW

NAME:
TITLE:

TELEPHONE:
SECRETARIES NAME:

ADDRESS:

MAJOR ABSENCES DURING NEXT FOUR MONTHS:

In this interview you will be asked to identify those developments within education over the next five years, (roughly between now and 1990) which are either plausible or for which there is potential as a result of the continued introduction of computers to education. Please use the following definitions of plausible and potential futures:

Plausible future:	What will be. What might conceivably come about under the normal course of events.
Potential future:	What might be. What is practically possible. Alternative futures.

Prior research has identified five broad areas which are often viewed as being of importance to computers and education. These areas are: (1) acquisition and funding; (2) courseware; (3) curriculum; (4) organizations; (5) teacher training. A brief description will be provided to clarifiy each of these areas. You may wish to modify the description provided. You will be asked to identify the major plausible and potential futures for each of the areas within the next five years as a result of the introduction of computers to education.

If you feel that any of the areas are not important to the study of computers and education please say so. In addition, towards the end of the interview you will be invited to add any areas you feel should be included in the study.

When making responses please consider them within the context of public education.

INTERVIEW GUIDE

1. ACQUISITION AND FUNDING
   (i.e. computing equipment, programs, facilities)
   a. What do you foresee as the plausible future in this area?
   b. What do you foresee as the potential future in this area?

2. COURSEWARE
   (i.e. development, evaluation and distribution of learning materials)
   a. What do you foresee as the plausible future in this area?
   b. What do you foresee as the potential future in this area?

3. CURRICULUM
   (i.e. what students learn, the way students learn, which students learn)
   a. What do you foresee as the plausible future in this area?
   b. What do you foresee as the potential future in this area?

4. ORGANIZATIONS
   (i.e. planning for computers, structure of educational organizations)
   a. What do you foresee as the plausible future in this area?
   b. What do you foresee as the potential future in this area?

5. TEACHER TRAINING
   (i.e. preservice, graduate training, inservice, continuing education, individual study)
   a. What do you foresee as the plausible future in this area?
   b. What do you foresee as the potential future in this area?

6. OTHER AREAS
   Are there any other areas not already covered in this interview which you view as being important to the study of computers and education?
   a. What do you foresee as the plausible future in this area?
   b. What do you foresee as the potential future in this area?

APPENDIX D

ROUND II PACKAGE OF MATERIALS

Edmonton, Alberta
November 6, 1984

Dear

Attached please find your package of materials for Round II of a study on "Computer Technology and Education" which I am conducting in partial fulfillment of my doctoral dissertation in educational administration. Participation in Round II requires you to complete a questionnaire which should take approximately 30-45 minutes of your time.

The names of participants in the study have been included on the inside of the front cover. During the Round I interviews it was very evident that all participants in the study were very active individuals. The time you've already taken to participate in the study, as well as your future participation, is greatly appreciated.

It is not necessary to return this questionnaire through the mail as I intend to collect questionnaires, whenever possible, in person. I will be contacting you in the next few days to arrange for an appropriate time for pick up.

I am looking forward to your responses.

Sincerely

Lloyd Steier
Doctoral Candidate
Educational Administration

ROUND II
QUESTIONNAIRE
OF A STUDY:

COMPUTER TECHNOLOGY
AND EDUCATION

Lloyd Steier
Dept. of Ed. Adm.
U of A, Edmonton

* The following was contained on the inside cover of the Round II Questionnaire:

Participants in the Study:

Mrs. J. Bererton	-Teacher, Edmonton Public
Dr. G. Bevan	-Director of Curriculum Branch, Alberta Education
Dr. T. Blowers	-Director Program Review, Research Liaison, Edmonton Public
Mrs. G. Cathcart	-Teacher, Edmonton Public
Mr. A. Donovan	-Education Specialist, Apple Canada
Mr. N. Fedirka	-Principal, Leduc County
Dr. S. Hunka	-Director of Educational Research Services, U of A
Mr. G. Kozak	-Computer Literacy Consultant, Edmonton Separate
Dr. M. Petruk	-Professor of Education, U of A
Mr. B. Pitzel	-Teacher, Vice-Principal, Leduc County
Mr. R. Schienbein	-Executive Assistant, Strathcona County
Ms. P. Redhead	-Consultant, Microcomputer Services, Edmonton Public
Dr. G. Romaniuk	-Associate Chairman, Department of Educational Psychology, U of A
Mr. C. Roxburgh	-Associate Director, In-Service Manager, Computer Technology Project, Alberta Education
Dr. J. Thiessen	-Vice-President Research and Development, Novachem Laboratories Ltd.
Mr. J. Travers	-Learning Systems Branch, Advanced Education
Mr. D. Wighton	-Clearinghouse Manager, Alberta Education
Dr. P. Wright	-Manager Distributed Systems Team, Information Services, Edmonton Public

INSTRUCTIONS

Welcome to Round II of a three round study on "Computer Technology and Education." In Round I of the study participants were interviewed and asked to identify those developments, over the next five years, which were either probable or possible as a result of the continued introduction of computers to education. From the interview data 798 statements about the future were generated. These statements were categorized and condensed into the 100 statements which are included in this questionnaire. You are requested to rate the probability and desirability of each of the statements in the questionnaire. The questionnaire has been pilot tested and takes approximately 30-45 minutes to complete.

A rating scale is included at the top of each questionnaire page. You may also find the following definitions useful:

Probability: The likelihood or chance of the predicted development occurring within education over the next five years.

Desirability: The extent to which you feel the predicted development is agreeable or worth having in education.

Individual responses will remain anonymous.

Thank you for your co-operation.

Sincerely

Lloyd Steier
Doctoral Candidate
Dept. of Ed. Admin.
7-104 Education North
U of A, Edmonton
ph. 435-5928 or 432-3094

Please rate the probablility and desirability of each of the following statements by circling the appropriate number.

		Highly Probable / Probable / Uncertain / Improbable / Highly Improbable	Highly Desirable / Desirable / Uncertain / Undesirable / Highly Undesirable
I.	ACQUISITION AND FUNDING:		
1.	Computer funding and support will increase at all levels.	1 2 3 4 5	1 2 3 4 5
2.	Computers will be funded at the local level in a partnership arrangement involving the co-operation of a variety of organizations.	1 2 3 4 5	1 2 3 4 5
3.	Provincial funding for educational computing will be determined through a complicated interplay of social, political, and economic forces.	1 2 3 4 5	1 2 3 4 5
4.	In terms of funding for all of the areas related to computing, money for hardware will be the easiest to obtain.	1 2 3 4 5	1 2 3 4 5
5.	A small number of schools will be designated to test prototypes of new hardware/software developments.	1 2 3 4 5	1 2 3 4 5
6.	Computing equipment will continue to be housed in a variety of configurations and physical locations.	1 2 3 4 5	1 2 3 4 5
7.	Schools will continue to acquire computing equipment at a rapid rate.	1 2 3 4 5	1 2 3 4 5
8.	Subject areas and grade levels will compete for placement of computing equipment.	1 2 3 4 5	1 2 3 4 5
9.	Most of the newly acquired equipment will be placed in high schools.	1 2 3 4 5	1 2 3 4 5
10.	Computers will be increasingly used to perform school administration functions.	1 2 3 4 5	1 2 3 4 5
11.	Some individuals will perceive funding as being diverted from other needy areas in order to support computers.	1 2 3 4 5	1 2 3 4 5
12.	Much of the newly acquired computing equipment will be underutilized.	1 2 3 4 5	1 2 3 4 5

II. COURSEWARE/SOFTWARE:

		Highly Probable / Probable / Uncertain / Improbable / Highly Improbable	Highly Desirable / Desirable / Uncertain / Undesirable / Highly Undesirable
1.	Software will become part of an integrated instructional package (i.e. other items will be included such as cassettes, filmstrips, transparencies and print materials).	1 2 3 4 5	1 2 3 4 5
2.	There will be an educational courseware/software development industry within the province.	1 2 3 4 5	1 2 3 4 5
3.	The development of courseware suited for education will be a major problem.	1 2 3 4 5	1 2 3 4 5
4.	A large amount of commercial educational courseware will be developed by individuals who do not have a background in education.	1 2 3 4 5	1 2 3 4 5
5.	There will be an evolution of authoring systems that allow teachers to develop their own programs.	1 2 3 4 5	1 2 3 4 5
6.	There will be development of a local software industry tailored to provincial curriculum.	1 2 3 4 5	1 2 3 4 5
7.	Educators will become more involved in courseware development teams.	1 2 3 4 5	1 2 3 4 5
8.	More software will be developed for machines with large memory capacities.	1 2 3 4 5	1 2 3 4 5
9.	The quality and quantity of software will continue to improve and increase.	1 2 3 4 5	1 2 3 4 5
10.	Software will become increasingly user friendly.	1 2 3 4 5	1 2 3 4 5
11.	The inertia of all the existing software will discourage upward capability of hardware.	1 2 3 4 5	1 2 3 4 5
12.	A provincial agency, similar to a clearinghouse, will be involved in software evaluation and distribution.	1 2 3 4 5	1 2 3 4 5
13.	Rights to software will be purchased at the provincial level and distributed to schools at reduced prices.	1 2 3 4 5	1 2 3 4 5

		Highly Probable / Probable / Uncertain / Improbable / Highly Improbable	Highly Desirable / Desirable / Uncertain / Undesirable / Highly Undesirable
14.	There will be an increased sharing of inter-provincial/ state information related to software evaluation.	1 2 3 4 5	1 2 3 4 5
15.	Educators will continue to struggle with a definable set of criteria for courseware evaluation.	1 2 3 4 5	1 2 3 4 5
16.	A large portion of software that is produced for the education market will be inappropriate for use in education.	1 2 3 4 5	1 2 3 4 5
17.	Much of the software that is developed will support existing curriculum as well as existing approaches to instruction.	1 2 3 4 5	1 2 3 4 5

III. CURRICULUM:

1.	Computer technology will contribute to a re-examination of the whole curriculum area.	1 2 3 4 5	1 2 3 4 5
2.	There will be a continuous discovery of new applications for computers in instruction.	1 2 3 4 5	1 2 3 4 5
3.	Simulations will continue to be enhanced by computers.	1 2 3 4 5	1 2 3 4 5
4.	Increased individualization of instruction, made possible through the use of computers, will conflict with homogenous grouping by grade level.	1 2 3 4 5	1 2 3 4 5
5.	There will be more structure to what is taught in computer courses.	1 2 3 4 5	1 2 3 4 5
6.	The use of LOGO as an instructional tool will increase in elementary classrooms.	1 2 3 4 5	1 2 3 4 5
7.	Computers will contribute to a greater integration of subject matter.	1 2 3 4 5	1 2 3 4 5
8.	Apart from the area of technology itself, curriculum content in other areas will remain much the same as it is at present.	1 2 3 4 5	1 2 3 4 5

		Highly Probable / Probable / Uncertain / Improbable / Highly Improbable	Highly Desirable / Desirable / Uncertain / Undesirable / Highly Undesirable
9.	Computers will be utilized to enable students to learn greater amounts of existing subject matter.	1 2 3 4 5	1 2 3 4 5
10.	There will be less and less emphasis on teaching programming languages at the public school level.	1 2 3 4 5	1 2 3 4 5
11.	Courses on computer literacy will not exist.	1 2 3 4 5	1 2 3 4 5
12.	Word processing will change both physical and creative aspects of the way students write.	1 2 3 4 5	1 2 3 4 5
13.	New computer languages will evolve and be taught at the school level.	1 2 3 4 5	1 2 3 4 5
14.	The computer will present new opportunities for students with special needs.	1 2 3 4 5	1 2 3 4 5
15.	Computers will contribute to more individualization of instruction.	1 2 3 4 5	1 2 3 4 5
16.	Computer Assisted Instruction will become more prevalent.	1 2 3 4 5	1 2 3 4 5
17.	Computer Managed Instruction will become more prevalent.	1 2 3 4 5	1 2 3 4 5
18.	Computers will be used to teach repetitive activities that require mastery.	1 2 3 4 5	1 2 3 4 5
19.	Computer technology will foster a move towards "gradelessness" where each student is able to proceed at their own rate.	1 2 3 4 5	1 2 3 4 5
20.	Computers will increasingly be used as a tool of instruction to reinforce learning in a variety of subject areas	1 2 3 4 5	1 2 3 4 5

IV. TEACHER TRAINING:	Highly Probable / Probable / Uncertain / Improbable / Highly Improbable	Highly Desirable / Desirable / Uncertain / Undesirable / Highly Undesirable
1. Prospective teachers will be able to get a degree with a specialty in computers.	1 2 3 4 5	1 2 3 4 5
2. Computer courses will become mandatory in pre-service training.	1 2 3 4 5	1 2 3 4 5
3. A variety of educational organizations will be involved in delivering computer related continuing education programs.	1 2 3 4 5	1 2 3 4 5
4. Individual study will be the primary method of acquiring information about computers.	1 2 3 4 5	1 2 3 4 5
5. Computer related in-service will be compulsory for teachers.	1 2 3 4 5	1 2 3 4 5
6. Most graduates of the faculty of education will require computer related in-service.	1 2 3 4 5	1 2 3 4 5
7. There will be increased emphasis on courses in instructional psychology (i.e. the way people learn and how computers can be used to improve instruction).	1 2 3 4 5	1 2 3 4 5
8. Inadequately prepared instructors and poorly designed courses, offered by a variety of institutions, will foster a negative attitude among teachers toward computers.	1 2 3 4 5	1 2 3 4 5
9. There will be more graduate courses related to computer applications.	1 2 3 4 5	1 2 3 4 5
10. Every new teacher, upon graduation, will have used computers in a variety of courses not directly related to computing.	1 2 3 4 5	1 2 3 4 5
11. Teachers will be adequately trained to deal with the social impact of computers.	1 2 3 4 5	1 2 3 4 5
12. While teachers will be consumers of computer technology they will use it in a way similar to the way they use textbooks in that they will not be directly involved in programming, evaluation, and distribution.	1 2 3 4 5	1 2 3 4 5
13. Computers will contribute to a change in the teacher's role from a disseminator of knowledge to a facilitator of learning.	1 2 3 4 5	1 2 3 4 5

V. ORGANIZATIONS:	Highly Probable / Probable / Uncertain / Improbable / Highly Improbable	Highly Desirable / Desirable / Uncertain / Undesirable / Highly Undesirable
1. International technological competition will place an increased emphasis on computers in schools.	1 2 3 4 5	1 2 3 4 5
2. The development of technology will place increased expectations and demands on the education system.	1 2 3 4 5	1 2 3 4 5
3. Students with computers at home will make increasing demands on teachers.	1 2 3 4 5	1 2 3 4 5
4. With increased emphasis on computing the education system will become more dehumanized.	1 2 3 4 5	1 2 3 4 5
5. There will be increased public pressure for educational organizations to become more technologically oriented.	1 2 3 4 5	1 2 3 4 5
6. Computers will contribute to an increased pupil-teacher ratio.	1 2 3 4 5	1 2 3 4 5
7. Some of the elements of curriculum will be delivered off the school premises via computer technology.	1 2 3 4 5	1 2 3 4 5
8. In terms of improving quality of program offerings, computer technology will provide numerous opportunities for smaller rural schools.	1 2 3 4 5	1 2 3 4 5
9. The entire structure of educational organizations will be changed by the use of computers.	1 2 3 4 5	1 2 3 4 5
10. The use of computers will change the present classroom structure.	1 2 3 4 5	1 2 3 4 5
11. There will be a "grassroots movement" for computer related change.	1 2 3 4 5	1 2 3 4 5
12. There will be a "top-down movement" for computer related change.	1 2 3 4 5	1 2 3 4 5
13. The introduction of computers will contribute to stress within all educational organizations.	1 2 3 4 5	1 2 3 4 5
14. Instructional consultants at the system level will become increasingly computer knowledgeable.	1 2 3 4 5	1 2 3 4 5

		Highly Probable Probable Uncertain Improbable Highly Improbable	Highly Desirable Desirable Uncertain Undesirable Highly Undesirable
15.	Despite the increased use of computers the role of teacher, student, and principal will remain primarily the same.	1 2 3 4 5	1 2 3 4 5
16.	Computers will foster more parent involvement in the school.	1 2 3 4 5	1 2 3 4 5
17.	Those interested in computers in education will develop "people networks" wherein information is shared more horizontally among organizations.	1 2 3 4 5	1 2 3 4 5
18.	In relation to computers, external groups will continue to make conflicting demands on the educational community (i.e. the A.S.T.A., the A.T.A., the Home and School Assoc., the University, the Department of Education, Advanced Education).	1 2 3 4 5	1 2 3 4 5
19.	Existing inertia or resistance to change will inhibit meaningful computer related changes in education.	1 2 3 4 5	1 2 3 4 5
20.	Many talented, knowledgeable people in the area of computing will leave education.	1 2 3 4 5	1 2 3 4 5
21.	The university will not be able to meet the demands placed on it by a changing technological society.	1 2 3 4 5	1 2 3 4 5
22.	Educational organizations, in using their resources to maintain existing systems, will have very little energy for future planning.	1 2 3 4 5	1 2 3 4 5

VI. ETHICAL CONCERNS:

1.	The physical theft of hardware and software will continue to create problems.	1 2 3 4 5	1 2 3 4 5
2.	Software piracy will continue to create problems.	1 2 3 4 5	1 2 3 4 5
3.	We will have students breaking into all kinds of data bases.	1 2 3 4 5	1 2 3 4 5
4.	Confidentiality of files and information will be a problem.	1 2 3 4 5	1 2 3 4 5

		Highly Probable Probable Uncertain Improbable Highly Improbable	Highly Desirable Desirable Uncertain Undesirable Highly Undesirable
VII.	EQUITY:		
1.	Many students without a public school background in computing will be seriously handicapped when they enter first year post-secondary courses.	1 2 3 4 5	1 2 3 4 5
2.	Differential rates of adoption of computers will contribute to inequities in the education system and provide another example of the gap between the haves and the have nots.	1 2 3 4 5	1 2 3 4 5
3.	Parents who are able to choose schools for their children will use quality of computer education programs as a criteria for selection.	1 2 3 4 5	1 2 3 4 5
VIII.	OTHER AREAS:		
1.	New developments such as computer controlled laser disks and large monitors will be used in the classroom.	1 2 3 4 5	1 2 3 4 5
2.	Educators will strive for increased hardware standardization.	1 2 3 4 5	1 2 3 4 5
3.	Machines will become better, cheaper, faster.	1 2 3 4 5	1 2 3 4 5
4.	"Take home" computers will be available for students to borrow from school.	1 2 3 4 5	1 2 3 4 5
5.	New networks will appear at the school, system, provincial, and global level.	1 2 3 4 5	1 2 3 4 5
6.	Strategic problems related to networking will be resolved.	1 2 3 4 5	1 2 3 4 5
7.	The private sector will mount pressure on schools to train students in business related areas.	1 2 3 4 5	1 2 3 4 5
8.	As the use of computers expands, and their advantages become more apparent, there will be an increased demand for the use of computers in education.	1 2 3 4 5	1 2 3 4 5
9.	There will be a constant move towards an "ease of human interface" for operating systems.	1 2 3 4 5	1 2 3 4 5

IX. ADDITIONAL COMMENTS:

Your continued cooperation is greatly appreciated!

APPENDIX E

SAMPLE CROSS-TABULATION PRINTOUT FOR ROUND II QUESTIONNAIRE ITEMS

CROSSTABULATION OF V25 BY V26

V25 \ V26	Highly Desirable (1)	Uncertain (3)	Highly undesirable (5)	ROW TOTAL
1 Highly probable	13 100.0 81.3 72.2			13 72.2
3 Uncertain	1 100.0 6.3 5.6			1 5.6
5 Highly improbabl	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

CHI-SQUARE	D.F.	SIGNIFICANCE	MIN E.F.	CELLS WITH E.F. < 5
7.87500	4	0.0963	0.056	8 OF 9 (88.9%)

STATISTIC	SYMMETRIC	WITH V25 DEPENDENT	WITH V26 DEPENDENT
LAMBDA	0.28571	0.40000	0.0
UNCERTAINTY COEFFICIENT	0.33711	0.26691	0.45744
SOMERS' D	0.54902	0.84848	0.40580
ETA		0.63640	0.62361

STATISTIC	VALUE	SIGNIFICANCE
CRAMER'S V	0.46771	
CONTINGENCY COEFFICIENT	0.55168	
KENDALL'S TAU B	0.58678	0.0061
KENDALL'S TAU C	0.25926	0.0061
PEARSON'S R	0.60000	0.0038
GAMMA	1.00000	

NUMBER OF MISSING OBSERVATIONS = 0

APPENDIX F

ROUND III PACKAGE OF MATERIALS

Edmonton, Alberta
December 3, 1984

Dear

Welcome to the third and final round of a study on "Computer Technology and Education" which I am conducting in partial fulfillment of a doctorate in educational administration. Participation in Round III requires you to complete a questionnaire which should take approximately 45 minutes of your time.

I would like to take this opportunity to thank you for participating in Round II. The participation rate for Round II was 100%. Your continued participation in Round III is also greatly valued and appreciated.

It is not necessary to return this questionnaire through the mail as I intend to collect questionnaires, whenever possible, in person. I will be contacting you in the next few days to arrange for an appropriate time for pick up.

I am looking forward to your responses and hope to be sending you a summary of the study results in the new year.

Sincerely

Lloyd Steier
Doctoral Candidate
Educational Administration

ROUND III QUESTIONNAIRE OF A STUDY:

COMPUTER TECHNOLOGY AND EDUCATION

Lloyd Steier
Dept. of Ed. Adm.
U of A, Edmonton

* The following was contained on the inside cover of the Round III Questionnaire:

Participants in the Study:

Mrs. J. Bererton	-Teacher, Edmonton Public
Dr. G. Bevan	-Director of Curriculum Branch, Alberta Education
Dr. T. Blowers	-Director Program Review, Research Liaison, Edmonton Public
Mrs. G. Cathcart	-Teacher, Edmonton Public
Mr. A. Donovan	-Education Specialist, Apple Canada
Mr. N. Fedirka	-Principal, Leduc County
Dr. S. Hunka	-Director of Educational Research Services, U of A
Mr. G. Kozak	-Computer Literacy Consultant, Edmonton Separate
Dr. M. Petruk	-Professor of Education, U of A
Mr. B. Pitzel	-Teacher, Vice-Principal, Leduc County
Mr. R. Schlenbelg	-Executive Assistant, Strathcona County
Ms. P. Redhead	-Consultant, Microcomputer Services, Edmonton Public
Dr. G. Romaniuk	-Associate Chairman, Department of Educational Psychology, U of A
Mr. C. Roxburgh	-Associate Director, In-Service Manager, Computer Technology Project, Alberta Education
Dr. J. Thiessen	-Vice-President Research and Development, Novachem Laboratories Ltd.
Mr. J. Travers	-Learning Systems Branch, Advanced Education
Mr. D. Wighton	-Clearinghouse Manager, Alberta Education
Dr. P. Wright	-Manager Distributed Systems Team, Information Services, Edmonton Public

INTRODUCTION

This questionnaire comprises Round III of a three round study on "Computer Technology and Education." Very briefly, the study has proceeded as follows:

In Round I of the study participants were interviewed and asked to identify those developments, over the next five years, which were either probable or possible as a result of the continued introduction of computers to education. Data obtained in Round I were summarized and categorized into one-hundred statements about the future. These statements were included in a Round II questionnaire wherein participants were asked to rate the probability and desirability of each of the statements. Data obtained in Round II were categorized on the basis of participant rating of probability and desirability. Seventy-six of the Round II statements, while important to the overall study, were dropped from Round III. The Round III questionnaire consists of the remaining twenty-four statements about the future.

INSTRUCTIONS

The twenty-four statements contained in this questionnaire are placed in four sections on the basis of previous participant rating of desirability and probability. Each section is clearly labelled with appropriate instructions contained therein.

You are reminded that individual responses will remain anonymous.

Thank you for your continued cooperation.

Lloyd Steier
Doctoral Candidate
Dept. of Ed. Admin.
7-104 Education North
U of A, Edmonton
ph. 435-5928
or 432-3094

SECTION 1

ROUND II STATEMENTS REGARDED AS HIGHLY PROBABLE AS WELL AS HIGHLY UNDESIRABLE

(If you disagree with the overall group response for any of the statements please use the space available in part b to state the reason(s) why you disagree.)

1. Much of the newly acquired computing equipment will be underutilized.
   a. Of greatest concern at: (check as many as necessary)
      ___ provincial level ___ school level
      ___ regional level ___ university level
      ___ system level ___ other level, please specify _____
   b. Recommended strategies for reducing probability:

2. A large amount of commercial educational courseware will be developed by individuals who do not have a background in education.
   a. Of greatest concern at: (check as many as necessary)
      ___ provincial level ___ school level
      ___ regional level ___ university level
      ___ system level ___ other level, please specify _____
   b. Recommended strategies for reducing probability:

3. A large portion of software that is produced for the education market will be inappropriate for use in education.
   a. Of greatest concern at: (check as many as necessary)
      ___ provincial level ___ school level
      ___ regional level ___ university level
      ___ system level ___ other level, please specify _____
   b. Recommended strategies for reducing probability:

4. Software piracy will continue to create problems.
   a. Of greatest concern at: (check as many as necessary)
      ___ provincial level ___ school level
      ___ regional level ___ university level
      ___ system level ___ other level, please specify _____
   b. Recommended strategies for reducing probability:

5. Confidentiality of files and information will be a problem.
   a. Of greatest concern at: (check as many as necessary)
      ___ provincial level ___ school level
      ___ regional level ___ university level
      ___ system level ___ other level, please specify _____

   b. Recommended strategies for reducing probability:

6. Many students without a public school background in computing will be seriously handicapped when they enter first year post-secondary courses.
   a. Of greatest concern at: (check as many as necessary)
      ___ provincial level ___ school level
      ___ regional level ___ university level
      ___ system level ___ other level, please specify _____

   b. Recommended strategies for reducing probability:

7. Differential rates of adoption of computers will contribute to inequities in the education system and provide another example of the gap between the haves and the have nots.
   a. Of greatest concern at: (check as many as necessary)
      ___ provincial level ___ school level
      ___ regional level ___ university level
      ___ system level ___ other level, please specify _____

   b. Recommended strategies for reducing probability:

8. In terms of funding for all of the areas related to computing, money for hardware will be the easiest to obtain.
   (Clarification: Some individuals perceive there to be inadequate funding for areas related to computing, i.e. facilities, courseware, staffing, maintenance.)
   a. Of greatest concern at: (check as many as necessary)
      ___ provincial level ___ school level
      ___ regional level ___ university level
      ___ system level ___ other level, please specify _____

   b. Recommended strategies for reducing probability:

9. Some individuals will perceive funding as being diverted from other needy areas in order to support computers.
   a. Of greatest concern at: (check as many as necessary)
      ___ provincial level ___ school level
      ___ regional level ___ university level
      ___ system level ___ other level, please specify _____

   b. Recommended strategies for reducing probability:

10. The development of courseware suited for education will be a major problem.
   a. Of greatest concern at: (check as many as necessary)
      ___ provincial level ___ school level
      ___ regional level ___ university level
      ___ system level ___ other level, please specify _____

   b. Recommended strategies for reducing probability:

11. Existing inertia or resistance to change will inhibit meaningful computer related changes in education. (Clarification: Most individuals interpreted meaningful change as an integration of computers into the curriculum.)

a. Of greatest concern at: (check as many as necessary)

___ provincial level ___ school level
___ regional level ___ university level
___ system level ___ other level, please specify _____

b. Recommended strategies for reducing probability:

12. Many talented, knowledgeable people in the area of computing will leave education. (Clarification: Individuals may leave for a variety of reasons, two of the most often cited were better opportunities and/or frustration within education.)

a. Of greatest concern at: (check as many as necessary)

___ provincial level ___ school level
___ regional level ___ university level
___ system level ___ other level, please specify _____

b. Recommended strategies for reducing probability: