DOCUMENT RESUME

ED 323 986 IR 014 631

AUTHOR Tobin, Judith, Ed.; Sharon, Donna, Ed.
TITLE New Technologies in Education in Canada: Issues and Concerns. New Technologies in Canadian Education Series. Paper 17.
INSTITUTION TV Ontario, Toronto.
PUB DATE Aug 84
NOTE 96p.; For other papers in this series, see IR 014 615-630.
PUB TYPE Viewpoints (120)

EDRS PRICE MF01/PC04 Plus Postage.
DESCRIPTORS *Computer Assisted Instruction; Computer Software Development; Computer Uses in Education; Distance Education; *Educational Change; Educational Planning; *Educational Technology; Elementary Secondary Education; Equal Education; Foreign Countries; *Futures (of Society); *Instructional Improvement; Opinions; *Policy Formation; Postsecondary Education; School Business Relationship; Social Values
IDENTIFIERS *Canada

ABSTRACT

The final paper in a series of 17 studies on new technologies in Canadian education, this report focuses on the issues raised throughout the earlier papers. It begins with a summary of the educational activities in the use of each technology in education, i.e., film, television, and videotape; radio and audiotape; computer technology; teleconferencing; videotex/Telidon; satellite technology; and videodisc technology. The statements and conclusions in this summary are based on information, examples, and comments contained in the first 16 papers. Also discussed are issues and concerns relating to the use of technology in teaching and learning; planning for the development of technology in education; and changes in education. Essays written by nine representatives from educational institutions to present a cross-section of issues, opinions, and research on how learning can be enhanced through the use of technology are then presented: (1) "Views on Technology in Canadian Education" (Joseph Koenig); (2) "Technology in Education for the Future" (Catherine Ann Cameron); (3) "Policy Issues Relating to Computer Use in Education" (Tom Rich); (4) "The CAI Dilemma" (Robert J. D. Jones); (5) "The Thorny Question of Software" (Louise Dubuc); (6) "Planning for Technological Changes in Postsecondary Institutions" (James A. Humphries); (7) "Educational Technology" (Denis Hlynka); (8) "Integration and Intelligence" (Michel Umbriaco); and (9) "New Connections between Technology and Education" (Sylvia Gold). Short biographies of the nine contributors are included. (DB)

TVOntario

Office of Development Research
Bureau de recherche pour le développement

NEW TECHNOLOGIES IN CANADIAN EDUCATION

PAPER 17

NEW TECHNOLOGIES IN EDUCATION IN CANADA: ISSUES AND CONCERNS

Edited by Judith Tobin and Donna Sharon

Study Coordinator
Ignacy Waniewicz

August 1984

Papers in the Series

NEW TECHNOLOGIES IN CANADIAN EDUCATION

Paper 1	An overview of the educational system in Canada
Paper 2	Communications and information technologies in Canadian elementary and secondary schools
Paper 3	Communications and information technologies in community colleges in Canada
Paper 4	Communications and information technologies in Canadian universities
Paper 5	Communications and information technologies and distance education in Canada
Paper 6	Communications and information technologies and the education of Canada's native peoples
Paper 7	The provincial educational communications organizations in Canada
Paper 8	Educative activities of the Canadian Broadcasting Corporation and the National Film Board of Canada
Paper 9	Applications of new technologies in nonformal adult education in Canada: Two examples
Paper 10	Canadian cable television and education
Paper 11	Educational applications of videotex/Telidon in Canada
Paper 12	Educational applications of communications satellites in Canada
Paper 13	Educational videodisc in Canada
Paper 14	Educational teleconferencing in Canada
Paper 15	Telehealth: Telecommunications technology in health care and health education in Canada
Paper 16	The high technology industry and education in Canada
Paper 17	New technologies in education in Canada: Issues and concerns

Copies of these papers can be purchased from TVOntario, Box 200, Station Q, Toronto, Ontario, Canada M4T 2T1.

FOREWORD

We dedicate this series to its designer and director, Ignacy Waniewicz. His death on February 21, 1984, has left us with a feeling of immeasurable loss.

With uncanny intelligence, instinct, and energy, Ignacy introduced the first educational television programs in his native Poland in 1957 and rose to the position of Director of Educational Broadcasting. During the mid-1960s, he served as a Paris-based program specialist in the educational use of radio and television, working for UNESCO in Chile, Cuba, Ivory Coast, Upper Volta, Mexico, Egypt, Nigeria, Senegal, Ghana, Great Britain, United States, Switzerland, and Israel. Ignacy shared the experience and insight he gained from this work by teaching and writing in Polish, German, Russian, Hebrew, Spanish, French, and English. His achievements are widely recognized in the broadcasting and academic communities on four continents.

As Director of the Office of Development Research at TVOntario, Ignacy explored his farsighted and consuming interests in adult education, media literacy, television as a primary tool for lifelong learning, and most recently, the educational uses of new technologies. His work did much to shape and guide TVOntario's progress over the last 15 years.

It is with love and respect that we dedicate this series to Ignacy Waniewicz. In its enormous scope, its thorough documentation, its emphasis on concrete results, and its concern with educational issues, this series reflects both Ignacy's vision and his intellectual legacy.

Donna Sharon
for the Office of Development Research

Preface to the Series

NEW TECHNOLOGIES IN CANADIAN EDUCATION

These papers in the series "New Technologies in Canadian Education" are the result of an international commitment. In June 1980, the Third Conference of Ministers of Education of Member States of the European Region of UNESCO adopted a recommendation requesting the member states to carry out joint comparative studies on well-defined problems of common interest in education. At a subsequent meeting of the European Region National Commissions for UNESCO, 14 subjects were agreed on for joint studies.

The theme "New Technologies in Education" was selected as study #11. The 17 countries participating in the study are Austria, Belgium, Denmark, Finland, France, Hungary, Italy, the Netherlands, Poland, Spain, Sweden, Ukrainian SSR, USSR, United Kingdom, as well as Canada, Israel, and the U.S.A. who are also members of the UNESCO European Region. At the first meeting of the national coordinators from these countries, held in October, 1982, at the University of South Carolina in Columbia, South Carolina, U.S.A., a plan was adopted for the study. In the first phase of this plan, the individual countries are to report on the ways in which the new technologies are being used in education. (A brief outline of the international design is available on request.)

The Canadian Commission for UNESCO was requested to coordinate, on an international level, the first year of the study. We are grateful to the Canadian Commission for selecting TVOntario, and the Office of Development Research (ODR) to be in charge of this task. The ODR was also asked to coordinate the Canadian contribution to the study, with financial support from the Department of the Secretary of State. We gratefully acknowledge their assistance.

In preparing the Canadian review of the use of technology in education, the ODR contacted a number of educators, academics, government officials, administrators in educational communications organizations, and others, across the country. It became apparent that there was a strong need for a well-documented account of the uses of both the "older" technologies (e.g., film, audio, television) and the newer technologies (e.g., computers, videodiscs, videotex) in the complex Canadian educational system.

Early in 1983, several types of research activities began simultaneously: designing instruments to gather information from each type of institution or interest group, identifying uses and users of each type of technology, and exploring the areas where Canada's distinctive features predispose toward technological developments. The 17 papers listed on the back of the title page emerged as a result.

Information for these papers was provided by hundreds of individuals expressing their own views or reporting on behalf of educational institutions and organizations, government departments, public and private corporations. We extend to them our sincere thanks.

I would like to acknowledge the contribution made by Thelma Rosen who assisted in the development of the inquiry instruments and played a major role in the gathering of this information. The task of supervising the final editing, production, and distribution of the papers was assigned to Donna Sharon. Her resourcefulness and persistence have contributed greatly to the completion of this series. Sharon Parker typed most of the papers from the initial drafts to their final versions. Her dedication made it possible to complete the study in such a relatively short period.

While the preparation of these papers has been supported by the Canadian Commission for UNESCO and the Department of the Secretary of State, the papers' contents do not necessarily reflect the official views of either party on issues related to technology in education.

Ignacy Waniewicz
Study Coordinator
Director
Office of Development Research
TVOntario

January 1984

ACKNOWLEDGMENTS

It is impossible to list all the people who have contributed to the completion of this series - the contributors, the writers, the reviewers, the editors. However, I would like to express gratitude to them all for their work, which has made this series as comprehensive, current, accurate, and readable as possible.

The Canadian Commission for UNESCO asked the Office of Development Research at TVOntario to undertake this study, and I would like to thank the staff at the commission, particularly Mariette Hogue, for their assistance and enthusiasm. The Department of the Secretary of State and IBM Canada Ltd. also supported the study through the donation of funds.

Many departments at TVOntario played important roles in the preparation and distribution of the study: Information and Publications, Project Development, Revenue Development, Marketing, Graphics, Customer Service, and Printing Services. To all of them, I express thanks for their help.

For the project team in the Office of Development Research, the completion of this study has been a challenging, demanding, and rewarding task. The dedication, abilities, and energy of Sharon Parker, Thelma Rosen, Donna Sharon, and Audrey Mehler are most gratefully acknowledged.

Judith Tobin
Study Coordinator
Office of Development Research

August 1984

CONTENTS

INTRODUCTION

This series of papers originated as part of an international commitment by the Canadian Commission for UNESCO to describe the ways in which communications and information technologies are being developed and used in Canadian education. TVOntario and its Office of Development Research were asked to conduct this study. The interest expressed by Canadian educators encouraged us to undertake an extensive nationwide exploration of technology in education. The resulting series of 17 papers describes the applications of technologies in a variety of educational settings in all parts of Canada. Several hundred people across the country, working in education, government, and industry, provided the information included in the series. These people cooperated in all phases of the study by assisting in the collection of data, providing information about their activities, and reviewing drafts of the papers.

The first 16 papers centre on applications of technology in education, and include brief discussions on the issues and concerns expressed by people working in each area. In this final paper, the emphasis is reversed. The major part of this paper examines the issues raised throughout the earlier papers. To encourage national discussion, educators from across the country were invited to comment on the issues and offer recommendations. These educators were chosen to represent views from all parts of the country and from varying perspectives in education, government, and industry. Together their essays offer many insights and options concerning the continuing development of links between educational activity and technology.

As background to the discussion, this paper begins with a summary of the educational activities in the use of each technology in education. The statements and conclusions in this summary are based on information, examples, and comments contained in the first 16 papers.

THE USE OF TECHNOLOGY IN CANADIAN EDUCATION

Canada's large land mass contains vast areas with few residents as well as a more densely populated corridor along the southern border. In this environment, the use of communications technologies has always been important. From the world's first use of the telephone in Ontario to Marconi's first transatlantic radio broadcast to Nova Scotia, from the introduction of public broadcasting in the 1930s to an international acceptance of Telidon as a videotex format in 1980, Canada has been in the forefront of international communications developments.

Initially, communications technologies were used to convey information from a source to a receiver, as in radio or television broadcasting, film, and later videotape or audiocassette. Information technologies were defined as computer-based systems by which information could be found, delivered, and used. With more recent developments in computer technology and new technologies such as videodisc and Telidon, the distinctions between communications and information technologies are dissolving.

In Canada, policies concerning the use of these technologies in education are developed at the provincial level. There is no federal department of education, although in some areas of federal responsibility, such as employment or communications, the federal government develops and funds programs of an educational nature. Ten provincial and two territorial departments or ministries are responsible within their own regions for legislation, policies, organization, and administration at the elementary, secondary, and postsecondary levels.

Film, television, and videotape

The use of film, television, and videotape is well established in Canadian education. Films and film projectors are widely available in elementary and secondary schools, colleges, and universities. In schools, films produced by the National Film Board make up over one-quarter of educational film inventories; the balance comprises films purchased from commercial producers primarily in the United

States and in Canada, England, and Europe. Films are usually distributed to teachers and instructors from educational media centres or film libraries in their institution, school board, or region. Approximately one-half of Canada's elementary and secondary teachers use film in the classroom.

The production of television programs for use in education began in the 1960s. In the larger provinces - British Columbia, Alberta, Ontario, and Quebec - provincial educational communications authorities produce and/or broadcast educational programs for elementary and secondary schools. In most parts of the country, some educational programs are televised by the Canadian Broadcasting Corporation (CBC). At the postsecondary level, programs are broadcast by provincial networks or private stations as a component of college or university courses (telecourses) designed for students registered in distance education programs. A wide selection of educational programs aimed at general interest audiences are widely offered by provincial educational authorities.

Direct broadcast television is not commonly used in classroom teaching because of the widespread availability of media centres and distribution systems for equipment and videotapes. Many media centres do record programs off-air as a means of acquiring videotape programs.

Videotapes and video equipment are available in most educational institutions. The educational communications authorities in the larger provinces distribute or make available videotapes of their broadcast programs for distribution to schools in their own province. These videotapes are also sold to institutions or ministries of education in other provinces for use in colleges, universities, schools, and organizations outside the formal education system. Several of the smaller provinces also produce some programs to meet specific regional or local needs. Videotapes are now available in most subject areas and grade levels, and demand continues for new programs that are closely linked to the curriculum.

In colleges and universities, videotape viewing is increasing. In some courses, video equipment is also used to record individual efforts or events, and the videotapes are used to give feedback to students about their performances in public speaking or counselling, to study behavioral analysis in family or child studies, and to analyze movement in kinetics.

From most teachers' and instructors' point of view, film and videotape are seen as interchangeable. In most places, the purchase of videotapes is increasing more rapidly than film acquisitions. Reasons for this include the lower production and duplication costs of videotape, the ease of selecting and repeating sequences within programs, and the availability of systems for projecting large television images in lecture halls.

Elementary and secondary teachers usually receive only a few hours of training in operating equipment and in integrating the use of film, television, and videotape in their teaching. Further training is available for those teachers interested in the characteristics and educational uses of different media. In postsecondary institutions, some training is generally available to their instructors. Individual institutions have policies or expectations that their staff members become familiar with the use of film and video in instruction.

Students are instructed in the characteristics, use, and production of film and television in only a few elementary and secondary school programs, usually in language, social science, or technical courses. In colleges, approximately 10 to 20 per cent of full-time students examine pertinent aspects of media, primarily in communications courses or in business, psychology, health, or library courses. Some universities offer degree programs in communications studies. Production, repair, and maintenance courses are offered in several colleges.

In general, film and videotape are used as a supplement to instruction in many schools, colleges, and universities. While early predictions that they would supersede traditional methods of instruction have not been fulfilled, film and television have been incorporated into the teaching resources used by many teachers and instructors.

Radio and audiotape

Educational radio broadcasts, aimed primarily at senior elementary school students, were begun in 1936 by the Canadian Broadcasting Corporation in cooperation with provincial departments or ministries of education. With the growth of television during the 1960s, the appeal of radio lessened. National educational radio broadcasts were terminated by the CBC French network in the mid-1970s and by the English network in 1981. At present, educational radio broadcasting is found in three provinces. A radio network, CKUA, operated by ACCESS Alberta, offers 15½ hours weekly of educational broadcasts for students at all levels, as well as educational programming of a more general nature. In Ontario, Open College/Ryerson uses broadcast radio in offering credit and noncredit university level courses to students in its distance education program. In Manitoba, audiotapes of university lectures are broadcast for general audiences on rural radio stations throughout the province.

Although educational radio broadcasting today is limited, the production and use of educational audiocassettes are increasing. In some provinces, large numbers of audiocassettes are available for elementary and secondary school use; these are distributed by the CBC in Newfoundland, and by provincial educational communications authorities in Quebec and British Columbia. In other provinces, some audiocassettes are available from local or regional media centres. Audiocassettes are also used in combination with 35mm filmstrips or slides in many schools, especially in elementary schools.

Audiocassettes are used by some postsecondary institutions, most often in language instruction. They are usually produced in the individual institutions, often in conjunction with slides. On occasion, audiocassettes are obtained from the CBC or from other educational institutions. In Quebec, the Ministry of Education is involved in the production of audiocassettes for colleges. In some universities, lectures are taped for students who miss them or who would like to review the material.

Postsecondary distance education programs use audiocassettes in many of their courses. For example, the University of Waterloo, which offers degree programs by correspondence, uses audiocassettes as the central learning resource in most distance courses. Audiocassettes are used by other postsecondary institutions as a supplement to print material in both credit and noncredit courses.

Audio recordings alone are used less often than audiovisual materials, film, or videotape. The lower costs of production and equipment have made the use of audiocassettes appealing in specific circumstances, particularly distance education and language instruction, and some feel that their potential as educational resources has not been fully tapped.

Computer technology

During the 1960s and 1970s, computers were acquired by large educational institutions for use in administrative and research activities. Today, relatively inexpensive microcomputers have been introduced into most educational institutions to perform a variety of functions. In elementary schools, they are used to give students an opportunity to learn about computers. In many elementary schools, computers are also used for instruction in mathematics and, less frequently, for instruction in language skills, science, social studies, music, and other subjects. In some schools, computers are used to encourage creative writing or to develop skills in problem-solving and reasoning. Computers are also used to provide remedial exercises for students having difficulty with basic concepts or to offer enrichment activities for gifted students.

In secondary schools, computers are used in computer awareness and programming courses, and in teaching business principles and practices, including data processing and accounting methods. Computer-assisted instruction (CAI) is most often used in mathematics courses and less frequently in science, geography, music, and language classes.

In both elementary and secondary schools, the use of computers for school, library, and classroom record-keeping is growing. An increase in the use of CAI is seen as desirable, but is hampered by the scarcity of high-quality software and by the small number of computers available in most institutions. Major efforts to develop satisfactory software, and to increase the number of computers are underway in several provinces. Additional teacher training is also needed to enable the best use of computers in offering educational activities for students.

In response to marketplace demands for employees skilled in the new technologies, more than two-thirds of the community colleges in Canada offer courses in computer science and computer technology, including programming, operating, systems analysis, repair, and maintenance. In some colleges, specialized courses in computer-assisted design (CAD) and computer-assisted manufacturing (CAM) are being introduced into the curriculum. In addition, students in many college programs receive instruction in the uses of computers and in the latest industrial and scientific applications of technology. Most colleges share a belief in the need to provide computer literacy for all students and staff. Although many colleges are interested in using computers for instruction in non-computer subjects, this type of use is being introduced slowly; budgetary restraints and the scarcity of high quality software limit the use of CAI in the colleges. Some colleges do use computer-managed learning (CML) to keep records, monitor the use of courseware, develop test item banking and test preparation, manage and prescribe course materials, and to monitor students' progress.

All colleges indicate a desire for more hardware as well as software. Because of the costs involved, colleges are considering how best to provide for these needs. In addition, consideration is being given to changes in college structures and in the roles of faculty members in order to gain maximum benefit from the introduction of computer technology into the curriculum and into teaching and administrative functions.

Universities are using computer technologies in instruction, research, library services, and communications. Computers are used to support classroom instruction in a number of ways, including computation in math and sciences, compiling and analyzing data in the sciences, social sciences, and humanities, word processing, creation of graphics for various engineering and other design courses, and simulations in math and physics. As in the colleges, CAI and CML are seen as desirable, but implementation is limited by the scarcity of appropriate software.

Computers were first used to record and analyze research data in the 1960s by universities able to afford mainframe computers. As smaller computers and new database management systems appear, computer use in research is increasing. Researchers also use library data retrieval systems to locate pertinent information.

The organization and services of university libraries can be substantially improved by the introduction of computers, resulting in enhanced access to library materials by users and more efficient use of resources. Most university libraries have introduced or are considering the use of computers in purchasing, cataloguing, and circulating library materials. On-line searching and information retrieval from various databases outside the library and on-line public access to a catalogue of university holdings are also being introduced in many university libraries.

Computer networks are part of the communicatons systems at some universities. On-campus computer networks and, in some regions, local area networks linking several nearby institutions are being established. Electronic communications among faculty and departments, including libraries, is a useful result of this networking capability. Networks can be used to administer and manage course materials and activities, and can allow computer conferencing among groups of instructors and students. The use of computer conferencing capabilities for enhancing distance education programs is being studied. As funding permits, universities are eager to use communications and information technologies to facilitate interaction among faculty, local universities, students, and databases.

Overall, computer use in storing, handling, and retrieving information for administrative, research, and instructional purposes is growing. Using computers to provide educational and instructional experiences for students is seen as desirable, but more difficult to achieve. Software development efforts are now underway on a small scale in many locations, and on a larger scale where resources permit. In this new field, opinions are varied about the most desirable, potentially successful routes to take in the development of computer applications in education. The potential benefits of CML, CAI, and computer networking are assessed differently in different institutions.

At all levels, educational institutions are developing programs for teachers and instructors to teach about the capabilities and operation of the technology and to point out the potential benefits and difficulties of using technology in teaching and learning.

Teleconferencing

At present, approximately 20 of Canada's 71 universities and 30 of the 196 Canadian colleges use teleconferencing in their credit and noncredit programs. The use of educational teleconferencing networks is most highly developed in Newfoundland, Quebec, Alberta, and British Columbia.

Audio-teleconferencing enables three or more people in different locations to participate simultaneously in a telephone conversation. When used as part of a distance learning program, audio-teleconferencing is especially valuable in extending learning opportunities to people who live in communities far from a college or university. Experiences with educational teleconferencing indicate that live discussion and interaction among the participants and instructor can create a classroom-like learning situation. In more heavily populated areas, audio-teleconferencing can eliminate the need for instructors or students to travel and lessen the need for instructors to repeat material in several locations.

Teleconferencing can be used to offer continuing professional education programs to small communities, or to enable people in several locations to participate in the same program. Some regional teleconference sessions for professionals in law and medicine have been established on a regular basis. Occasional teleconferences have also been organized for educators, veterinarians, science writers, and other groups.

The format and content of teleconference courses vary greatly among institutions. Typically, however, textbooks and print materials are a major component of course materials. In some instances, slides or videotapes are provided for use during teleconference sessions or for later reference. Some institutions are examining the use of visual support via electronic technologies such as slow-scan television, electronic blackboards, or a videotex system.

Some experimentation has been done (most often using satellite transmission) with the use of two-way, full-motion video communications. Although pilot projects using visual as well as audio interaction have been very successful, costs prohibit extensive use. A more affordable intermediate step, using a combination of one-way, full-motion video and two-way audio, has been introduced in British Columbia. The use of computer conferencing as an educational communications system is also being developed on an experimental basis.

The addition of visual communication and the development of teaching techniques appropriate to the teleconferencing experience present challenges in designing effective programs. The costs of teleconferencing equipment and learning materials can be prohibitive, especially for small institutions. To keep costs at a minimum, equipment and resources can be shared among several institutions. For example, the Atlantic Provinces Association of Continuing University Education, a new association in eastern Canada, facilitates the sharing of resources among institutions and minimizes overlap among their programs. Such activities will encourage the development and success of teleconferencing in education.

Videotex/Telidon

Over the past five years, private industry and the federal Department of Communications have sponsored several research projects and field trials to encourage the development of commercially viable or self-supporting applications for Canada's videotex system, Telidon. At present, some educational services based on Telidon technology are becoming established; others are still in the development stage.

Few Telidon applications have been instituted at the elementary and secondary school levels. In Ontario, a Telidon network links 75 secondary schools, 15 youth employment centres, and 10 public libraries around the province. Career guidance information and an assortment of small-scale learning materials are available on this Telidon network.

Some colleges are introducing courses in Telidon page creation, marketing, and equipment repair; and some universities are participating in content development for Telidon databases. For example, the University of Western Ontario journalism program provide news reports to subscribers via a Telidon network, and the University of Guelph prepares Telidon pages containing agricultural information for farmers.

Distance education programs at the University of Calgary and Athabasca University in Alberta and at Télé-université in Quebec find Telidon's graphics useful in supplementing teleconference with visual material. The integration of Telidon graphics and PLATO (Programmed Logic for Automated Teaching Operations) software is a major component of a distance education service now being introduced by the Université du Québec. The networking capabilities of Telidon can also be used in making available a database of educational materials to distance students.

Closed Telidon networks for local use are being introduced in a few postsecondary institutions, primarily in Ontario. Such on-campus networks carry information about courses and about the institution in general. Networks and databases for special interest users, linking sites via telephone lines, are being developed or considered in several places. Two examples in Quebec related to health care include an information journal for the disabled and a health management information service for the general public. A national network is being developed by the Canadian Hospital Association to distribute instructional training materials and other information to its offices across the country.

Further efforts are now underway to develop Telidon adaptations to be used by people with special needs. These include the design of a Braille printer for the visually impaired, a pictorial Blissymbols-based system for individuals with no language facility, closed-captioned systems for the hearing impaired, and hardware modifications for the physically disabled.

Satellite technology

As with videotex/Telidon, several years of development and experimentation preceded the establishment of on-going services that depend on transmission of audio and video signals via satellite. The ability to transmit signals to communities in the far North is an especially valuable benefit of Canada's satellite technology.

Anik C3, a Canadian satellite launched by the United States space shuttle Columbia in 1982, is now used to receive and transmit educational programming in several parts of the country. Satellite transmission time is costly, and only large organizations or cooperative groups of smaller institutions can afford to make use of it. In two provinces, the educational communications authorities broadcast television programming. TVOntario distributes its signal via satellite to 12 main regional transmitters and 75 low-power rebroadcast transmitters throughout Ontario. Its usual broadcast schedule of 16 hours a day includes educational programs and series for preschool children, elementary and secondary schools, colleges, universities, and an array of programs and learning opportunities for the at-home viewer. The Knowledge Network in British Columbia offers a similiar broadcast service, but with greater emphasis on accredited telecourses and noncredit teleseries sponsored by colleges and universities in the province. Some courses or series are pretaped, others are broadcast live. Distance education programs in British Columbia are often enhanced by telephone communication between students and course instructors.

Early in 1985, Alberta will become the third province to broadcast educational programming via satellite. The Alberta Educational Communications Corporation (ACCESS) produces and acquires both radio and television programming to support school curricula, postsecondary distance education, and adult continuing education.

In the eastern provinces, the Atlantic Satellite Network (ASN) allots 20 per cent of its broadcast schedule, approximately 20 hours per week, to educational uses. The Distance University Education via Television program (DUET) at Mount Saint Vincent University in Nova Scotia is a major user of ASN satellite time, transmitting to 16 centres across the four Atlantic provinces. The signal is distributed from these centres by cable companies and is available only to cable subscribers. In some courses, registrants use the telephone network to participate in teleconference sessions. The satellite network is also used by the Nova Scotia Department of Education to distribute videotape programming to the public schools. Other educational institutions are developing proposals to use the network.

In 1983, a federally funded experimental project enabled the University of Saskatchewan to offer interactive educational programming to the four western provinces. Programs were distributed by the Knowledge Network in British Columbia and by cable companies in Alberta, Saskatchewan, and Manitoba. The major series transmitted, VETNET, was designed for practicing veterinarians in their homes. Viewers could respond by telephone. The system was also used to provide material for educators, farmers, and animal owners. Programs for the general public dealt with topics such as robotics, high technology, the arts, legal concerns, and health. At present, funding is being sought to continue this satellite-based service.

Satellite transmission has contributed to the expansion of distance education opportunities in several provinces by providing a television link to wider audiences. Considerable attention is now being paid to designing different types of distance learning opportunities, using satellite transmission of video materials in combination with other technologies in cost-effective as well as educationally effective ways.

Videodisc technology

A videodisc player transmits picture and sound to a television set or monitor. Laser videodiscs can store still and motion pictures on a numbered series of 54,000 frames so that, on command, any point or sequence on the disc can be displayed accurately and quickly. Videodiscs have two audio channels. A microcomputer linked to a videodisc player can offer sophisticated computer-assisted instruction and training. In this interactive mode, the monitor will display portions of the recorded material according to learners' responses or choices. This interactive capability creates interesting possibilities for individualized learning experiences.

Several videodiscs designed for educational or training purposes have been developed in Alberta, British Columbia, and Ontario by private companies and by educational institutions, often with the assistance of grants from interested government departments. Many of the discs produced offer instruction in work-related skills for nurses, teachers, correctional officers, foresters, automobile sales staff, mechanics, and machinists. Some videodiscs provide students with information or instruction on such subjects as the circulatory system and Indian culture. Others are designed for a wide range of viewers: for example, in one educational game viewers' decisions about ways of living can lengthen or shorten the life of the person shown on the television screen; other videodiscs show novices how to use an IBM personal computer and explain some key programs.

Videodiscs have been considered for use in many institutions, but actual experience with them is limited. The high costs of developing and producing a videotape master, the inability to alter recorded material, and questions about the acceptability and availability of videodisc software have discouraged investments in videodisc technology.

Conclusion

Technologies have been used in education both to supplement classroom teaching and to provide learning materials for distance education programs. In the classroom or lecture hall, teachers and instructors in most educational institutions have available a variety of films, videotapes, audiocassettes, and, on a smaller scale, computer software to draw upon in planning their lessons and directing students' activities.

Teachers and instructors use these technologies to introduce, review, enrich, or summarize a lesson, and to direct students to pertinent materials, individually or in small groups. These activities stimulate student interest, expose them to situations outside their experience, present new information and concepts, encourage participation in related activities, and foster an exchange of ideas.

With varying amounts of assistance and encouragement from their institutions, individual teachers and instructors locate available material, arrange for its use, and integrate the material into their teaching activities. Many factors come into play in influencing these teaching activities: the quality of available programs and their suitability in a particular situation are important elements, as is ease of access to information about programs, to the programs themselves, and to the necessary equipment. Teachers' attitudes and training, influenced in part by the approach of their institutions, also affect the use of technology.

Technology has played an important part in the recent expansion of distance learning programs in Canada. Many colleges and universities use one or more of the technologies to support or partially replace print materials and to provide opportunities for personal contact and discussion.

The hardware developments over the past 50 years in communications and information technologies are impressive, but their applications in education have often produced less dramatic results than anticipated. Identifying the most successful experiences and the reasons for their success is instructive. Both in distance education and in classroom instruction, the most exciting applications of technology occur when experiences are offered that attract adult learners with new types of learning opportunities, that foster students' development of concepts and understanding, or that tailor education to suit the needs and styles of individual learners. But using technology to create learning situations like these is a challenging, time consuming, costly process.

For people in communities far from postsecondary institutions or people who find traditional teaching methods ineffective or unappealing, technology holds great promise. The ability of technology both to enhance traditional teaching and to extend learning opportunities seems substantial. Developments in educational technology may eventually alter our basic approaches to education and the organization of educational activities.

Additional developments in hardware and educational software can be expected. Combining several technologies to develop new learning experiences is beginning - for example, in the integration of videodiscs and computers and in satellite transmission and telephone communication. Expected developments such as voice recognition and speech synthesis, expert systems, and artificial intelligence may provide new capabilities for educational use.

A look into the future of technology in education suggests that new combinations of technology-related experiences can enhance the teaching/learning process, provide new learning opportunities, and lead to restructuring of some educational programs and processes. However, enthusiasm about the possibilities for new technology-based educational experiences is easily tempered by the practical, pedagogical, and philosophical concerns expressed in the following sections.

ISSUES AND CONCERNS

The use of new technologies in education - computers, teleconferencing, Telidon, satellite communications, and videodisc - suggests the possibility of fundamental changes in the structure and operation of the education systems in Canada. At present, however, developments are focusing on the use of these technologies within the existing educational system. This section presents an outline of the issues surrounding the incorporation of communications and information technology in education today, followed by a discussion of developments that may lead to fundamental changes in education.

The introduction of technological innovations in the educational system raises a series of familiar educational issues. Educators are continually concerned with facilitating learning, improving teaching methods, and developing well-designed teaching materials. Ongoing concerns are the role of the federal government in education, teacher training, equal access to educational opportunity, and the allocation of limited resources. The use of technology in education adds a new dimension to these issues.

Developing the use of technology in teaching and learning

The fundamental concern is the way in which technology can be used to facilitate learning, improve teaching, and develop successful learning materials. In some cases, the usefulness of technology seems clear. Teleconferencing is used to permit classroom-like exchanges between learners and instructors in distance education programs. Satellite transmission of television programming allows educational institutions to supplement print materials for distance learners. In these situations, technology is used to meet the need for improved communication.

In most cases, however, the utility of technology is less obvious. The questionable quality of most educational software, for example, illustrates the inadequacy of many efforts to use the computer's capability to enhance learning. Most applications are designed to substitute for teaching activities by providing instruction, practise exercises, and testing. It may be that attempts to use technology in education results in no substantial improvement over present teaching methods and do not warrant the costs of software development and hardware acquisition. It is true, however, that some computer-assisted instruction has proven as effective as live teaching, particularly in skills training. Research findings are inconsistent and efforts to develop and assess computer-assisted instruction continue.

Other approaches to the use of computers in education are being developed. Some applications enable students to direct the computer activity, for example, word processing or spreadsheets. Students can also use the computer as a research tool for storing, locating, and retrieving data. Efforts are underway to develop tools especially for use in education, as has been done with LOGO. Another strategy focuses on the management of information relating students' characteristics, educational resources and activities, and students' academic performance.

In developing applications for technology, educators are trying to determine sound methods for designing technology-based learning materials. These efforts are hampered by a lack of understanding of how people learn from technology. There are few precedents for successfully applying new electronic capabilities in teaching and learning. Strategies for the development of traditional teaching aids such as textbooks, worksheets, or audiovisual materials are often transferred to the development of software. Although useful in some ways, such practices can lead to a failure to maximize the opportunities for interactivity, student control, and individualization. In developing software for computers, Telidon, or videodisc, designers can plan for individual differences in learning style.

Consideration is being given to the combinations of expertise needed in designing educational applications of communications and information technology. Finding the ideal mix of visuals, text, and learner reinforcement or determining the effective use of structure and sequence challenge the capabilities of educational designers. Teachers, instructors, and specialists in curriculum design, instructional materials, educational psychology, graphics, and computer systems can all contribute to software development. The goal of using Canadian expertise to develop materials appropriate to our cultural needs creates additional interest in software development efforts.

Once a successful use of technology in education is developed, further adaptation is needed to integrate technology with other learning experiences effectively. At present, it is the teachers' task to incorporate the use of technology with related educational activities. Teleconferencing, for example, requires teachers accustomed to the benefits of face-to-face interaction to adjust their presentation style to the absence of visual cues and to anticipate the need for visual materials. The use of computer software requires planning to link students' activities with other learning experiences.

Despite our limited understanding of how best to incorporate technology in teaching and learning processes, educational institutions are developing ways of using various combinations of technologies to offer learning opportunities to students. Experience, evaluation, and research will help to refine and resolve some of the issues raised above.

Planning the development of technology in education

Planning processes raise familiar questions of jurisdictional mandates, teacher training, hardware and software acquisitions, budgeting, and equitable distribution.

In Canada, where education is a provincial responsibility, planning and decision-making are conducted independently in each province, or with limited interprovincial consultation. Some programs are developed by the federal government, at times in consultation with the provinces, to achieve such national goals as full employment or a bilingual society. The involvement of the federal government in education is a complex issue.

From an industrial perspective, Canada's decentralized educational system is seen as a disadvantage compared to a single market or national English/French markets large enough to support the development of educational software and other educational applications. Additional pressures for national cooperation come from the less wealthy provinces which lack the resources necessary for the development of educational technology. New types of cooperation and accommodation are being sought in order to benefit from the economies of scale without sacrificing opportunities to serve provincial needs.

In areas such as communications, federal responsibility overlaps with the provincial responsibility for education. New developments in communications invite the development of educational applications of these technologies. By funding initial study and development of technical capabilities and applications, the federal government is providing unusual opportunities that might not otherwise be affordable. Examples of these projects include satellite distribution in distance education and development of videotex databases. The stages between initial experimentation and the establishment of an on-going educational service are difficult and costly, however. At times, successful experimentation can create a demand in situations where continuing operation is now impractical. Another area of overlap between federal and provincial governments involves training for employment. As part of its efforts to deal with unemployment, the federal government has given grants to many Canadian colleges for the development and use of technology in skills training. In summary, it appears that through increasing participation in activities related to educational technology, the role of the federal government in education is growing.

Provincial ministries or departments of education, regional school boards, colleges, and universities are planning programs for teacher training and for the acquisition of hardware and software. The use of technology in education requires teachers and instructors to become 'computer literate' and, where appropriate, to use technology in their teaching activities. For those involved in teaching computer literacy courses or such computer-related subjects as business, the need for training is most urgent. Institutions are considering the extent of training for different staff members, suitable methods for offering training, and the kinds of programs needed. Difficulties arise when teacher demand is greater than the capacity to offer training or when discrepancies arise between administration and staff concerning the level or quality of training. In some instances, teachers feel resistant to or threatened by their institutions' efforts to encourage training in educational technology.

Provincial departments or ministries of education and educational institutions are now involved in determining the kinds of hardware needed, the relative benefits of centralized or decentralized decision-making and purchasing of hardware, and the need to subsidize local or departmental purchases. Several computer manufacturers have been active in selling to the education market. The hardware capabilities needed and the value of compatibility of equipment among institutions are two of the issues now under consideration. Concerns about compatibility become especially important when communication networks are developed to provide electronic mail services, or to distribute software among institutions and educational systems.

Software acquisition involves similar questions of centralization or decentralization of decision-making and purchasing. Initially, both hardware and software acquisition depended on the initiative of individual teachers and instructors. As computer use increases and more software becomes available, provincial ministries of education, colleges, and universities are formulating policies and programs to evaluate software, adapt some computer programs to specific circumstances, and develop systems for software distribution. The economies of a centralized approach to such tasks are attractive, and efforts are being made to encourage regional and national cooperation. Reluctance to relinquish control and independence will be weighed against potential advantages and savings. Software development efforts require attention to the pedagogical issues discussed earlier, the benefits of centralization or decentralization, and the uncertainties in securing copyright to software.

In planning the development of educational technology, institutions and provincial ministries of education must be guided by two overriding concerns: the desire to provide equal benefits to all students, and the finite budgets with which governments and institutions must operate. The growing visibility of computer technology in society has created a demand for its introduction in education and provided a justification for expenditures. Only a small fraction of institutional budgets is available for learning materials of all kinds or for research or development; demand for technology in education often outstrips the ability to pay for it. In larger institutions or provinces, the funding base may allow more leeway for investment in demonstration projects of new applications. Planning is more likely to be cautious and constrained in less wealthy jurisdictions. Determining the most effective use of funds and justifying expenditures are on-going issues in the use of technology in education.

The underlying value of providing equal opportunity of access for all students is of particular concern in the use of technology. On the positive side, technology is often used most successfully in education to extend learning opportunities to people for whom educational programs are inaccessible or inconvenient and to people with physical or learning disabilities. At the same time, there is concern about the possibility that technology might become more readily available in wealthier communities and institutions than in poorer ones and that its use could be less extensive in 'have not' situations. Differences between wealthy families able to purchase technological tools for their homes and poor families with less access to technology might not be balanced by exposure to technology in educational settings. Reducing the disparities between boys and girls in their use of technology is another area that requires attention. In many situations, girls choose to spend less time using computers than boys do and are less likely to select technology-related courses. The consequences of these differences for later employment options is of particular importance. There is widespread recognition of the need to avoid inequities based on social class or gender, and programs designed to lessen such inequities are being developed in some institutions.

Changes in education

New technologies are, like older technologies, being incorporated primarily as teaching aids in a largely unchanged educational system. However, some early experiences in developing interactive learning materials, in designing technology-based programs of study, and in using communications media indicate the possibility of changes in education. There is considerable support for the development of technology-related educational resources in the high technology and communications industries, as well as in government and educational institutions. Continued willingness to invest in new technologies as educational tools may gradually lead to an accumulation of new learning resources. Improvements are expected in the design of technology-based educational resources and in technological capabilities. Although widespread success in providing high quality learning opportunities and experiences through technology is some years away, potential clearly exists for an increasingly learner-centred approach to education, involving alternative approaches to learning, teaching, and organizing educational institutions. The following discussion looks at activities that suggest the beginnings of educational change.

Indications of change are found in the present development of distance education programs and in applications of technologies designed to offer an alternative to classroom instruction. In recent years, the demand for distance education has grown substantially in all parts of the country. Teleconferencing and satellite transmission capabilities have been marshalled to extend and improve distance programs that offer opportunities for independent learning. However, the costs of developing and offering distance education programs have created a need to coordinate the purchase and operation of communications equipment and services and the development of curriculum materials. Regional and national organizations are being formed to foster cooperation and cost sharing among institutions. Jurisdictional concerns such as regional boundaries for learner markets and reluctance to transfer credits among institutions are beginning to diminish.

The use of computer-assisted instruction is being introduced as an alternative to classroom instruction in some subject areas. Development of computer-managed learning systems in postsecondary institutions, particularly for vocational educational and training, offers another approach to using computers as a substitute for traditional teaching activities. The current use of Telidon and videodisc in education may also indicate ways to employ technology to provide individualized educational experiences.

Combinations of technologies for distance education and for on-campus or in-school teaching are also being used. Interactive video technology, linking computer technology with videotape or videodisc, is used effectively in skills training, and similar applications are being implemented in other educational areas. Teleconferencing is being supplemented with electronic visual material delivered via several media, including Telidon, slow-scan television, and satellite broadcast. Combining the capabilities of several technologies can result in increasingly sophisticated educational resources and programs.

Programs that employ technologies singly or in combination are designed to produce individualized learning experiences, to increase the ability of such learning experiences to match individual learning styles, and to develop curricula for technology-based learning. Students can proceed at their own pace, and can sometimes hasten the learning process. The kinds of human interaction among teachers and students, and the proportion of learning that is mediated by technology, vary among the different programs. The experience gained through these programs, accompanied by research and evaluation studies, may lead to a greater understanding of the conditions necessary for the successful use of technology in education and may suggest ways to improve the design of technology-based educational resources.

The commercial sector, including publishing companies, private educational institutions, professional associations, and large industrial enterprises is becoming interested in offering technology-related learning opportunities. New types of learning materials are beginning to appear for use outside as well as within traditional educational institutions - in homes, libraries, community organizations, workplaces, special interest organizations, and social clubs. The growing role of industry in providing training for employees, particularly in the technology industry, is evident today. Increasing educational opportunities outside the educational system will offer learners greater choice among the educational resources, times, and locations available to them.

Future developments may lead to an increase in new technology-based educational resources. Lower prices for equipment would encourage extensive experimentation, speed development, and foster new activity. For example, widespread availability of inexpensive communication channels would enable communications among widely scattered groups of people. Ready access to experts, peers, and information may support and encourage greater independence in learning. Increasing compatibility in operating systems, programming languages, and authoring systems may result in substantial cost savings. Expected developments in voice recognition and speech synthesis, in expert systems, and artificial intelligence would open up new possibilities for educational applications, although these developments could also increase costs.

The remaining discussion considers changes in education that might result from the development of technology in education. If the efforts described earlier meet with success, the result could be a growing understanding of fundamental learning and teaching processes. Educators could define new guidelines for using the capabilities of technology to provide effective individualized learning experiences. In such a situation, we might expect to see an increasing availability of high quality educational resources for individualized learning and a reconsideration of the central role of classroom instruction. A willingness to use technology in education on the part of learners, teachers, and institutions would be necessary. At this point, ideas about educational activities and system of the future are very speculative. Substantial changes would seem most likely to begin at the postsecondary level, although some new approaches could be introduced in elementary and secondary schools.

Changes in the responsibilities and expectations of teachers, learners, and educational institutions may be considered. Learners would develop greater awareness of their learning styles and needs, and the development of learning skills would receive greater emphasis. Learners would have the opportunity to select from an array of educational resources developed and distributed by a large number of educational institutions and private producers. In order to benefit from these resources, learners would require considerable familiarity and experience with technology. Increasing flexibility would free educational activities from the constraints of time and place. Learners would become sophisticated consumers, skilled in identifying their needs and selecting from among the types of learning programs available.

Teachers would spend less time in presenting information to groups of students and become more involved in tutoring individuals, guiding discussion among students, providing opportunites for the integration of learning and experience, and developing abilities not well served by alternative resources. In a context of technology-based learning programs, teachers would play an important role in guiding individual students toward appropriate learning resources, helping to resolve difficulties, and supplementing available learning materials. Teachers would also be involved in preparing and evaluating technology-based learning materials that incorporate information-giving, administrative, and instructional features. In assessing students' progress, teachers would be less concerned with students' mastery of content and more concerned with their ability to integrate and apply learning.

Institutions would focus more directly on the development of learning opportunities and flexible systems for delivery. In scheduling and locating activities, institutions could become increasingly responsive to the needs of interested learners. Study at home or at work would likely increase as the role of classroom teaching declined. New methods for recognizing educational achievement and offering accreditation or certification may allow students maximum access to the offerings of various institutions.

Economic and cultural influences, as well as developments in education and technology, will undoubtedly play a major part in determining the scope of change in education. Visions of education that incorporate extensive use of technology raise concerns about the decline of personal contact among students and teachers, and about the emphasis on technology-related skills and vocational education at the expense of the 'liberal arts' approach to education. New technological capabilities offer the potential to individualize and expand educational opportunity; at the same time, they raise the possibility of confining us in an educational environment dominated by those very capabilities.

An expanded role for technology in education is only possible with the convergence of a number of factors. Growing understanding of how people can learn through the use of technology, the design of educational resources that reflect learners' needs, learning styles and responses, falling costs, acceptability of and demand for technology-based resources by the learner, and increasing flexibility on the part of institutions and learners in moving toward learner-centred education are all indispensable. The absence of any one will limit the use of technology and related changes in the organization of education. One can imagine learner-centred education made possible through the use of technology, but the extent to which such development will prove desirable, possible, practical, and affordable remains to be seen.

INTRODUCTION TO THE ESSAYS

A number of representatives from educational institutions, associations, government ministries, and industry were invited to contribute short essays on issues and concerns about technology in Canadian education. Each was asked to consider a number of themes - the values and politics of technology in education; the impact of technology on educational programs and processes; software development; and the availability of education and access to it - and to offer his or her views and recommendations. Through this collection of papers a number of topics are reintroduced and reconsidered from a variety of perspectives. This diversity of opinion demonstrates the complexity of the interrelationship between technology and education. The essays contain some recurring themes: the impact of technology on society and especially on education; the policy issues and external pressures related to the use of technology in education; the appropriate role of technology in education; software development; and the need for planning. Each paper offers explicit and implicit recommendations for the integration of technology into education.

The potential of technology to change radically the educational system, the curricula, the delivery methods, and the roles of teacher and learner is the central thesis of the essay by Joseph Koenig. He discusses the obstacles to achieving these changes and the ideal learning situation that could be available if the obstacles are overcome.

In her essay, Catherine Ann Cameron raises a number of questions about the social implications of technology. She presents ideas for the socially and educationally appropriate applications of technology in schools. Tom Rich also considers the introduction of technology into schools, but his attention is focused on the policy issues that arise from the widespread use of technology in education.

Two essays are specifically concerned with software. Robert Jones considers the role that computer-assisted instruction could play in education, why it is not yet filling this role, and how the potential and the reality might be reconciled. Louise Dubuc discusses the limitations of developing software from a theoretical base of content, teaching, or learning. She calls for action-based development to increase the supply of effective software. Turning to the issue of hardware acquisition in postsecondary institutions, James Humphries describes the common problems of ad hoc purchasing and offers suggestions for avoiding them.

Educational technology is not limited to the computer. Denis Hlynka reviews some of the literature on the variety of technologies and their implications for learning. Michel Umbriaco considers the integration of technologies a major step in their effective use. This theme is developed through the examination of the socio-economic context of Canadian education and the consequent impact of technology on education.

The changes in society that have been triggered by technology are placing new pressures on the educational system. In the final essay, Sylvia Gold considers the causes and nature of these pressures and offers recommendations on responding to them.

These essays represent a cross-section of issues, opinions, and research regarding the central question of how learning can be enhanced through the use of technology. Experiments and applications are numerous, but results are inconclusive. The sharing of our endeavors, our successes, and our problems is a crucial step toward resolving the issues that surround the use of technology in education.

The opinions expressed in these essays are solely those of the authors and do not necessarily reflect the opinions of TVOntario.

VIEWS ON TECHNOLOGY IN CANADIAN EDUCATION

By Joseph Koenig
Interactive Images Technologies Inc.

The value and politics of technology in education

Technology as such is not central to the future well-being of western society; perhaps it was during the industrial age but today it does not give one society an edge over any other. If there is any one thing that is vital to western society (or human society in general), it is the ability to think imaginatively and innovatively, to be able to focus one's creative imagination and to redefine reality in an unending series of inquiries, using technology as a tool. This is the way in which we must earn our bread and butter in a world where virtually everyone has (or soon will have) all the technical skills and motivations to make products that are cheaper and better than the ones we made yesterday.

This emphasis on using our minds constantly to redefine reality comes with great difficulty to many. To master this use of the mind requires practice. Lack of practice and lack of confidence can stifle the imaginative and creative process.

In Canada, for example, a strong colonial tradition, an abundance of natural resources, and a variety of cultural and political factors have tended to discourage development of the ability to think through many issues with clarity or to see innovative human thought as the chief requirement for survival and growth. We have tended to assume that Canada's role is to provide resources, while the "motherland" or head office - first Britain, now the United States - provides the intellect and direction.

Our cultural and political realities have led us to emphasize compromise as an essential part of our survival process. This is laudable, but it does cause a certain bias in our thinking. To Canadians, important issues are those that respond to legal processes - redefining what is rather than exploring what may be. Perhaps as a result of defining reality in legal terms, our education system is fragmented and seems to emphasize the provincial control of education -

even in the very smallest and poorest provinces - at the expense of intellectual excellence and the training of imaginations.

In Canadian education, too many interests are vested in retaining the status quo to put much stock in energetic, enlightened cooperation. Many people are paid very well to maintain distinct educational enclaves. Naturally, they justify their actions without great difficulty. Right now, computer and communications technologies permit high school students studying microbiology or Canadian literature or pre-European history to talk to each other and to work on joint projects, even if they live as far apart as Whitehorse, Halifax, and Toronto. However, I believe that such direct contact between learners will be a long time coming in the school system because it may undermine existing educational structures; for many educational bureaucrats, survival is at least as important as learning.

To overcome the limitations to creative learning caused by this bureaucratic fragmentation, a new national curriculum could be developed and implemented in a matter of a few years via the marvelous "electronic highway" that is now in place. However, provincial boundaries and old mind-sets erect toll gates across the highway, impeding those educational changes that are perceived as threats to established positions. At the same time, ironically, no attempt is made to provide constraints on the wall-to-wall deluge of often mindless electronic trivia from the United States.

Those who work in our educational system will have to refine and develop their intellectual abilities. Teachers must become better informed about the world in general and more inclined to encourage or at least recognize creative thinking in their classroom. Creative thought should be encouraged in the sciences, mathematics, and the arts. Encouraging young people to be risk-takers in business should be part of it too.

The notion that our technological world requires a strong focus on technology in schools is an attractive one because it permits educators and political leaders to "do something" that appears responsive. Of course, it is true we need many competent technical people, but even more than that, we need people who will know how to devise, adapt and utilize technology. We need to recognize that our new kind of world, where abundant natural resources are no longer a sure meal ticket, is one in which an ability to cope successfully with change is essential.

Learning about a particular form of technology is of little value in itself; nor is emphasis on technology at the expense of the arts or social sciences useful. Understanding and enjoying music, literature, and poetry may well be essential to understanding and mastering science and technology.

The impact of technology on educational programs and processes

Until quite recently, most children left school between the ages of 14 and 16; they worked until the age of 65, if they lived that long. They dealt with changes in the nature of work in a variety of ways, and few involved formal education. In fact, the formal education of children had little to do with preparing youngsters for their adult lives. Schools placed emphasis on transmitting information about a finite world, not on developing an ability to tackle difficult problems in a dynamic one. Today, machines handle many of the routine tasks in our society. It is the more challenging tasks that require human thought and action. An education that prepares the student to deal with special challenges is no longer for the elite alone - the officer class. It is an ability we all need.

Conventionally, subjects are taught as if they were a series of separate packages of knowledge. Relatively little emphasis is placed on acquiring an integrated body of knowledge to use in making effective decisions. Exam results continue to be mistakenly thought to demonstrate an ability to apply what one has learned, and students have few opportunities to practice decision-making in the classroom. This situation can now be changed dramatically for the better through the use of available new technologies such as computers, laser videodisc systems and telecommunications. These technologies can be used to create a learning environment that is responsive to the needs of the individual students.

The opportunity exists to provide interactive educational programs that stimulate the acquisition of knowledge about how things relate to each other, and an ability to apply such knowledge in a problem-solving context. For example, a computer and videodisc simulation on a theme such as Canadian history becomes a vehicle for dealing with issues central to almost every subject on the curriculum. International Cinemedia Centre Ltd. set this goal in a recent history simulation developed on behalf of the Ontario Ministry of Education, <u>The Bartlett Family</u>. This project represents a first step toward well-designed programs that make full use of the extended memory, graphics and networking capabilities of the ICON (the new Ontario educational microcomputer) or similar equipment. A program that permits students to make decisions affecting the lives of a fictional pioneer family in Ontario can be adapted for subjects other than Canadian history; it could be used, for example, in projects dealing with world history, geometry, composition, or literature.

Thus, it is possible to develop a few major units of study that integrate subjects and give them structure. The various assignments in each thematic unit can be designed so that individuals or groups of students can tackle the work. The material covered will be suitable for students with a range of skill levels, perceptual styles, and interests. The more capable students will be challenged to their limit, while the less skilled will proceed as their ability permits. Add to this integration the ability to "network" students at various locations, and we see the great potential that is now available to Canadian education - if the opportunity is seized.

How should curriculum design proceed? It seems that a school year could be centred on a number of major projects or units that combine traditional research and essay elements with computer-based simulations in which students work individually, in face-to-face teams, or with others at distant locations. Various traditional subjects and a variety of learning styles would be thoroughly explored over the course of a few school years. The design of these integrated projects should involve leading scholars and creative people, as well as teachers and others. In many cases the students' work will probably be good enough to become a permanent part of the course material.

The teacher's role becomes much more demanding in such an environment; he or she helps the student to see the interplay of events and ideas, and encourages students who may be inclined to take a particular point of view to shift and explore the subject from another perspective. Traditional textbooks are probably not appropriate for this kind of learning.

For students, the result of the approach suggested here would be a better understanding of how things connect - how math and pioneer barn building go together in the pioneer history unit, for example. They will be able to draw on their own knowledge to achieve results in other areas, and they will be more motivated to learn when they see how their knowledge can be applied.

Two important ideas arise out of technological developments:

- New interactive technologies make it possible for the student rather than the teacher to be at the centre of his or her own learning process. It is necessary to think through the ramifications of this statement carefully. So far, we have made little effort to do so.

- The task is no longer to make sure that the student takes in all the necessary information required; it is to ensure that he or she learns to pick and choose what is relevant from the mass of data available. Today, schools still tend to function as if they were teaching from a finite body of knowledge.

The educational system will also have to better serve the needs of adult learners. In my view, much of the escapist television watching now going on is not a sign that people are happy being passive viewers, but rather is an indication that they are looking to television for something and not finding it. Television in the home could become an extension of the interactive learning environment in the formal education system. Continual learning for virtually every adult will become essential. Schools will have to rethink their role and open their doors to mature students. They will need to encourage their young students to enjoy learning so that they will want to keep coming back as long as they live.

An increased emphasis on subject integration, self-directed learning, research skills, and continuing education are only some of the ways schools can cope with new changes in learning needs. However, these are practical approaches that can be worked on now to help bring about the series of transitions that schools will have to go through if they are to remain relevant.

I believe that these approaches will open up opportunities for students in remote locations and less advantaged schools everywhere, allowing them to be in touch with their peers across (and even beyond) Canada. Computers, laser discs, and satellite linkage are the relevant technologies for the present, although not all of these need to be used simultaneously to create an interactive learning environment.

Software development

Probably the only way to get better at developing, recognizing, and using good software is to become actively involved with it. Just as people who cannot read cannot judge writing style or literary forms, so educational systems that try to define the role of the computer without some first-hand exposure will not be very successful. An active, open-minded investigation of what can be done is required, and it must involve the brightest, most capable people, those who are not afraid of change where change is appropriate. However, if one keeps in mind that the printing of books is half a millenium old, yet there are many school systems which continue to function as if printing had never been invented, one should not assume too much about the certainty of change.

The cost of educational software is cheap or expensive, depending on what criteria one uses. It is not expensive when compared to television productions, or even to educational television or to the production of a textbook; it is expensive when development costs must be borne by a school or school board. One needs to look at the cost/benefit equation - not always easy to do, of course - to get some sense of what the real cost is. If one does, cheap software may turn out to be quite expensive, and vice versa.

There is probably no one right way to develop educational software. Teachers may develop some of it, as may authors, students, or teams of people from other disciplines. Again, there is a need to explore the possibilities in order to encourage excellence, and, at the same time, economy. The Ontario Ministry of Education has taken a leadership role in this regard, a role that few other jurisdictions have had the energy, courage, or funding to try.

Generally speaking, it is a useful idea to begin by deciding what one wants students to learn, what students find difficult to learn at present, and what teachers find difficult to teach, and then examining the ways in which software can meet those needs.

The availability of education and access to it

The rich may not have exclusive access to computers, but those who have access to computers will, in a sense, become rich because such access gives them power, which translates into wealth.

Many students now considered to be poor learners are experiencing difficulty with the current communications technology, which is heavily print-oriented. Certainly these learners can and should have access to computer-based and/or laser disc materials that can help them deal with their problems. Ideally, programs should be designed so that all learners can find the material that is right for them, find their level of difficulty, and work from there.

Women and girls should be considered carefully in designing the new materials for learning. There is no inherent reason that women should not be as successful as men in the use of the computer. If the new technology does not attract as many female students as males, something is wrong with the way the technology is being applied, not with the technology itself.

The goal of education should be to make learning opportunities universal, inside and outside school buildings, for males and females, for young and old. Learning should be sufficiently exciting, challenging - and successful - that everyone would want to be a non-stop learner. To be denied the opportunity to learn should be viewed as a form of cruel and unusual punishment to be prohibited by law.

TECHNOLOGY IN EDUCATION FOR THE FUTURE

By Catherine Ann Cameron
University of New Brunswick

The societal impacts of the microprocessor are only beginning to be envisioned. The one thing that is clear is that our children will inhabit a radically different world from the one in which their parents live. How are we to prepare them for this new age, one commonly referred to as an information age, but one that may better be thought of as a knowledge age? Educators are on the front line of this change.

In an information age, the distinction between information and knowledge may be more important than ever before. If we see data, information, knowledge, and wisdom on a continuum, an understanding of the differentiation of each of these sources of human choice will be crucial. It is also important to differentiate between education and training. "Education" means the development of a general knowledge base out of which can spring the wisdom of educated choices. "Training" focuses on the transfer of data and information so that appropriate action may be taken. Traditionally, the nominal emphasis in schools has been on education, but in reality much time has been spent on training. Increasingly, schools may focus on education in the broader sense of the word, as other institutions and automation begin to take on the task of training.

In contrast, the distinction between work and play may diminish. As the microprocessor penetrates the workplace, work as we currently know it will change dramatically. These changes will force us to re-examine our notions of the nature of work and its place in our lives. The work-play dichotomy will dissolve into a work-learning-recreation continuum. Many of our activities will end up at surprising new points on the continuum, and perhaps few or none of them will be undertaken for pay. The place of education may be located at all points along the continuum: the workplace, the learning place, and the home may all occupy the same physical space.

The emergence of an information society has many social implications. Equality of access to the sources and products of information technology is of central importance. Although hardware costs are rapidly diminishing, they are still high enough to raise the spectre of a class of "information poor." This impoverishment could add one more major source of differential access to social opportunity. For instance, it is already the case that wealthier provinces have made commitments to introduce technologies that poorer provinces have not yet considered. Further, in some communities, students of lesser ability are restricted to drill and practice computer usage, whilst more able children are treated to the luxuries of solving problems using computer programming and the like. Such discrimination could create an unfortunate new dichotomy in educational wealth which could contribute to one of the less desirable scenarios for an information society, one in which there will be two classes of citizens: the very small pilot (or programmer) class, and the much larger cabin crew (or user) class, and between these classes there would be no opportunities for upward mobility. The special needs of specific subgroups in the community will require a concerted effort on the part of hardware and software developers if the benefits of mainstream resources are to be equitably distributed. The handicapped and the elderly, for example, can benefit from hardware designed to meet their needs. Ignoring their needs for adaptation could increase the alienation already experienced by many of them.

As the nature of the workplace changes, new employment issues will have to be dealt with by government, industry, and the educational community, as well as the individual worker. The issues are related not so much in the increase or decrease in employment opportunities triggered by information technology as to the examination of the very nature of work, training, and lifelong education.

Given the questions raised, what might the responses of the educational community be?

When does one introduce microcomputers, for example, into the classroom? How many computers are appropriate, and in what areas of the curriculum will they be most beneficial? These questions have yet to be answered, but in my opinion the introduction of computers is most creatively effected when children are just starting to become literate and numerate, that is, in the primary classroom.

Introducing children to computers at the time they start school has a number of advantages. First, young children are quite likely to be free of sex-stereotypical responses to the technology. Second, their reactions to errors are not as deeply entrenched as they will later become. Because computer programming provides an environment in which errors are a challenge for improvement, young children are presented with an extraordinary opportunity for cognitive growth.

The computer should not be employed as a separate entity with a contentless program; rather, it should be integrated with all subject matter in the curriculum. The child would learn to read and write using a word processor as one of many tools available to assist in developing skills. By learning to program in a computer language specifically designed to create a facilitative mathematical environment, such as LOGO, the child begins to work with numbers and spatial concepts. The computer will not replace effective traditional means of teaching literacy and numeracy, but will be an addition to the stock-in-trade of a creative learning environment.

To date, there is no evidence to show that young people working with computers in schools become more isolated or socially restricted than other children. In fact, the opposite seems to be true. An increase in communicativeness and cooperation of students using computers, however, may be a function of the scarcity of hardware; the sharing of microcomputers is the norm in many schools.

The impoverished quality of the currently available software may make it appropriate for schools to wait until there are richer program resources before purchasing hardware. This is logical if the students are seen only as users of externally created software. Many educators, however, see learners as active agents in their own intellectual development and envision the greatest potential of the microcomputer in the interactivity possible when students are programming or using software to assist in the creation of written text. This is possible now.

The absence of appropriate software may be a blessing in disguise. While the poverty of content may create more educational technological agnostics than one might hope for, it also provides the necessary time to acclimatize ourselves to the possibilities at hand, and may result in materials that will be needs-driven rather than imposed from outside the educational community. Software development cannot be left to the software developers. Educators must have the lion's share of responsibility in development if the materials are to be useful to students. Some observers believe that the potential for software development will not be realized until the children who have been exposed to computers at an early age reach maturity. If this prediction is correct, we have a decade or two to go before we will be treated to the potentials now hinted at.

This brings us to the teacher and the curriculum. It has been feared that the computer would make inroads on the traditional content areas of curricula and on the need for teachers. Although it is true that our view of what is "core" to a curriculum is subject to societal changes in consensus, it is crucial that young people be exposed to the humanities and the social sciences if they are to place in perspective the wonders that science and technology have wrought. Further, the science and art of expert systems and intelligent computer-assisted instruction have a long way to go before they will replace an experienced teacher. Of course, there may be times when the explorations of a child are best monitored by a sensitive, intelligent resource person, but there are many other times when a computer could do a more accurate, consistent, and patient job. The day may be near at hand when the first-class teacher will participate only in high-level teaching interactions, with the aid of a bank of automated assistants. Teachers must be educated to do what they do well better, in consort with the high-technology communications media.

The values of personal autonomy, flexibility, and creativity, if they are high on our list of educational goals, are certainly within the grasp of a knowledge-age curriculum. Those involved in the socialization of our young have a challenging task before them. Questions must be raised regarding the priorities in a creative curriculum for the future education of our children. If priority is given to the opportunity for every child to be challenged to his or her full potential, an information age offers some unique possibilities. For example, job differentiation based on differences in physical strength is obsolete. Of course, questions emerge as to whether verbal and quantitative skills are distributed differentially between the sexes. With the development of new technologies, however, especially as software proliferates and as new high-level languages emerge, sex differences will increasingly become irrelevant. Our children will be able to fulfill their potential in ways previously unanticipated.

At present, however, women must guard against "disfranchisement" with respect to the new technologies. Women are significant users of word processors, and while there is nothing inherent in the technology to exclude women, they must focus on attaining greater familiarity with the design and development of software and hardware. Without these skills, they will be hampered in their participation in the decision-making regarding the application of technology in the home, the workplace, and the school.

I have written this essay primarily from the perspective of an educator. But as a researcher I must qualify many of my assertions by emphasizing that in many areas we lack the data upon which to base our actions or policy proposals. If we fail to evaluate carefully the variety of applications currently available and their attendant outcomes, we do so at a great personal and cultural risk.

* * * * * *

NOTE: Much of this paper is derived from studies conducted by the Social Impacts Subcommittee of the federal Department of Communications Canadian Videotex Consultative Committee. The consideration of microcomputers in education was supported by the Social Sciences and Humanities Research Council of Canada.

POLICY ISSUES RELATING TO COMPUTER USE IN EDUCATION

By Tom Rich
Prince Edward Island Department of Education

Today we are in the midst of a revolution brought about by the advent of what is often called the "new information technologies" - the marriage of computers with communications.

The introduction of computer technology to education has been considerably different from that of other technologies adopted by educators. This is apparently due to four factors. The first, of course, is the radical impact of computers on the workforce. It has been estimated that in the next several years between 50 and 70 per cent of all jobs will be computer related. Thus, there is tremendous pressure from employers to ensure that the schools prepare students to deal with the use of the new technology in the workplace. Second, the pressure to teach about and to use computers comes as much from outside the educational system as from within. Never before have parents and the media called upon schools to adopt a particular "machine" for use in teaching. Nor have we ever seen so much direct involvement of home-and-school associations and parent groups in purchasing computers for schools. The third factor is the reaction of students to computers. A significant number seem excited and eager to become involved with computers. Computers appear to be unique in their ability to motivate and captivate students. Finally, those promoting the computer have stressed its potential to change radically the educational system and the way we learn. Perhaps fuelled by the obvious interest of young people in computers, a common assumption has arisen that computers can and will change the structure of education. This belief is complemented by the first factor mentioned - the obvious effect of computers on the workplace.

Business and industry, and more recently governments and parents, apparently have accepted the inevitability of these predictions, and are now calling for the educational system to make use of and teach about computer technology.

Policy issues

The present and potential applications of computers in education raise a number of important issues. Some result from the nature of the societal changes attributable to the widespread use of computers, and some from their specific application in schools. The following is not an attempt to provide answers, but rather to raise questions. In most cases the answers will be neither simple nor readily apparent. Only after we have more fully explored the uses of computers and observed their effects on society will the answers become clear.

Work and school. The most significant use of computers in schools to date is based on the assumption that a high percentage of jobs will be computer related. This is a misleading idea. Although U.S. estimates have suggested up to 30 million people will engage in computer related jobs, the vast majority of workers will require no formal training about computers. Rather, it appears that the actual number of jobs requiring specific "high-technology" training will be small. In fact, the new technologies may cause structural unemployment and create more low skilled jobs. Of the 20 occupations generating the most new jobs not one is in high-technology. The largest increases will come in occupations such as janitors, nurses' aides, sales clerks, and waitresses and waiters.

Thus, the effects of computers in and on the workplace may be more complex than many realize. It is too simplistic to suggest that knowing how to operate or program a computer is a guarantee of future employment as the need for computer-related skills may be significantly less than anticipated. In particular, the ability to program will probably be of use to comparatively few workers; computers are rapidly learning to program themselves, and new generations of computers require less and less specialized knowledge. For the average business computer user, the emphasis will be on knowing how to apply the power of a computer, not on knowing how to program it.

There is no denying the pressing need to train and retrain workers and managers in order to develop the variety of new skills required in the information society. But, as Larkin Kerwin, president of the National Research Council of

Canada, suggests, it may be more important for schools to turn out graduates adaptable to change than ones with over-specialized skills.[1] As a result, the need for lifelong access to education and training opportunities will assume increasing importance.

Curriculum changes. The now commonplace study of computer-related courses in our schools should not lead us to adopt an unnecessarily narrow approach to computer education. There is a real danger that our schools can become over-specialized, particularly in relation to education about technology. Becker cautions that the primary purpose of vocational education is not to fit the individual into a single job opening, but to help the student grow as a person and develop self-confidence, standards of excellence, a spirit of cooperation, and a love for work.[2] Vocational programs involving computer technology are falling short of the mark if their emphasis is on developing specific skills. The rapid advances in technology, ever-changing skill needs, and new job requirements demand that we produce students who are both adaptable to change and knowledgeable about the impact of technology on business and industry.

Instructional uses. The use of any technology must be judged by its appropriateness. The critical standards used in evaluating other educational materials must be used to guarantee that computer software is suitable, free of bias, and high quality. By the same token, the use of the computer itself should encourage student growth and individuality and not simply be based on rigid performance objectives.[3] Care must also be taken to ensure that skills being learned at the computer are or can be generalized to other areas.

For example, LOGO is used so that the student will have control over the computer. Papert contends that this control will dramatically increase the student's reasoning ability at an early age.[4] Unfortunately, the supposed benefits from using techniques such as LOGO are based almost entirely on anecdotal evidence and on Papert's writing. There is no hard evidence that problem-solving learned in connection with the computer translates to other tasks.

The results of computer-assisted learning are more apparent but, to date, are hardly revolutionary. This may reflect both the software being used and the tendency to use it in a traditional linear fashion. This is not to suggest that the computer does not offer potential for improving some facets of teaching and learning. Computers may be particularly useful when combined with other presentation devices such as videodiscs or videotape recorders and software responsive to learner needs and styles. The computer may also serve as a tool to assist in managing instruction, a role for which it seems well suited.

It is necessary for educational policy-makers to adopt specific strategies and guidelines to determine the instructional uses of technology. To do this, the following issues should be addressed:

1. Does the use of computers offer a unique educational advantage?

2. Is the use of computers financially possible?

3. Are interested and trained teachers available?

4. Is the computer's role in the program well planned and well defined?

5. Is relevant and good-quality software available?

Equality of access. There already exists strong evidence that sex bias in the use of computers arises early.[5] In many instances this seems to result from unconscious reinforcement of male uses of the computer and from software that emphasizes games and rewards that appeal to boys. There is also a growing concern that children from economically disadvantaged families may not have access to computers, in either the home or the school. It is important to make certain that these children are given equal opportunities ' learn to use computers and other technological devices. The use of computers in education should not result in the creation of an elite because of the cost of the technology or the type of student that is encouraged to use it.

Teacher training. Probably the most important factor in the use of a technology in education is the presence of teachers who are trained and comfortable with that technology. Computers are currently being used by the committed few; widespread use in schools will not take place until the majority of teachers have had training in the use of computers in education.

Change, particularly for adults, is a highly personal experience that may require attitude change as well as skill change. Thus, it is vitally important that staff-development programs address attitudes as well as skills training. Simply mandating in-service training for all teachers in the use of computers in education is not the answer. Resistance to change may be centred on the way in which new programs are administered. In fact, this may increase the fear of technology. Programs designed to upgrade teachers' computer skills and change attitudes toward technology must be planned with great care. A recent survey shows that four factors play a large part in determining teacher receptivity toward in-service training: teachers should be part of the decision-making and planning; the programs should be well-structured and substantive; they should relate directly to classroom use; and they should be ongoing and based on local needs. Programs designed to increase teachers' knowledge of and willingness to use the new information technology will only succeed if these factors are taken into consideration.[6]

Costs of technology. The costs of introducing new technology to the classroom can be high. According to most estimates, half an hour a day of computer time should be available to students. To meet this recommendation, about two per cent of a school district's total educational budget or about $50 per student per year would have to be allocated.[7] This does not seem like much until one considers that the expenditures on all instructional supplies used in education - books, films, and other materials - amount to only 2.5 per cent of the budget.[8] There is already some evidence that expenditures on computers and computer software are diverting funds from purchases of more traditional materials. This would pose little difficulty if these were one-time expenditures; however, the rapid developments in computer technology and the continuing need for new computer software mean that the expenses are ongoing. The need for a more rational approach to funding the introduction of technology into education is evident. Current funding programs are almost exclusively short-term. A way must be found to determine effectively the cost and benefits of new technology and to budget realistically for the required hardware and software.

Conclusion

The advent of the new technologies in education has had the beneficial effect of forcing us to analyze both the entire educational process and the ways we are dealing with the process. The computer undoubtedly has a role to play in education, but it cannot do the job alone. Our task is to find appropriate uses for the computer and to help prepare our students, not just for jobs, but for the prospect of lifelong learning. The relationship between the world of work and education and the impact on curriclum must be clarified. Appropriate instructional uses of the computer must be determined and the problems of equality of access dealt with. Finally, in order to implement desired changes, massive teacher in-service training may be necessary along with a reorganization of funding priorities.

Computers in the school may be used to change the way we learn, and they may become a personal learning tool for students. The challenge for us is to discover how to make the marriage between the new technologies and the school one that will endure and produce a better system.

NOTES

1. Matas, R. "Schools Turning Out Too Many Specialists, NRC President Says." The Globe and Mail. 20 April 1983.

2. Becker, H.J. "How Schools Use Microcomputers." Classroom Computer Learning. September, 1983, pp. 41-44.

3. Smith, S. Address to the Conference on Computers in Education. Ottawa: Science Council of Canada, 1983.

4. Papert, S. Mindstorms. New York: Basic Books, 1980.

5. Fisher, G. "Access to Computers." The Computing Journal. April, 1984, pp. 24-27.

6. Mohan, E.M. An Overview of In-service Education and Training of Teachers in the Provinces of Canada. Toronto: Council of Ministers of Education, 1982.

7. Moursund, D. "The Two-Percent Solution." The Computing Teacher. March, 1984, pp. 3-5.

8. "Education Statistics." Service Bulletin. Vol. 4, No. 9, December, 1982, pp. 1-6.

THE CAI DILEMMA

By Robert J.D. Jones
Sheridan College of Applied Arts and Techology

If computer-assisted learning is as good as its proponents claim, why is there not more of it? Expectations that computer-assisted learning should by now be playing an important role in education remain unfulfilled. Computers have entered every sector of our society, including our schools, but the computer application that is most appropriate to education is the one that is least evident there. Computer-assisted instruction (CAI) is not a new phenomenon; educational technologists have been conducting research and developing CAI since the mid-1960s. When CAI did not live up to its earlier promises, its failure could be conveniently blamed on the high cost of computer hardware. But we are entering the second decade of the microcomputer revolution, and lack of access to computers is no longer a valid excuse: there is hardly a school in North America that does not have at least one microcomputer, and there are more computers in people's homes than in schools. Where is the educational software that promises to individualize instruction, that allows students to advance at their own pace, that reduces the time and effort needed to acquire basic skills, that involves the learner in engaging simulations, and that can bring the world's store of information into the classroom?

This essay examines some of the reasons for CAI's lack of progress and suggests some solutions to the dilemma. I will argue that the heart of the problem has little to do with computers, programming, or even cost. The CAI dilemma is an educational one: we are ambivalent about the place of instructional technology in education. Our means of communication shape our institutions and our relationships with one another. The dominant instructional communication form, teacher-led classroom instruction, has produced an institution that serves many other social needs besides education. CAI and other twentieth-century instructional technologies, if exploited to their full potential, would produce an institution where traditional classroom instruction, if not replaced, would be largely re-placed. Why has this not happened? It is not that educators resist innovation; in fact, we are sometimes too quick to jump on bandwagons. The problem is that in absorbing innovations and adapting them to fit into existing institutional structures, innovations are often stripped of their unique characteristics. Added to this problem is the educator's tendency to abandon innovations before they have had a chance to mature. As a consequence of our ambivalence, we know too little about the design and delivery of instructional communications, even in the more mature technologies such as television. These arguments will be developed further following a brief description of the current state of CAI.

The focus here will be on one application of the computer in education: computer-assisted instruction. The computer has many other roles to play in education. It is used to generate report cards, balance budgets, and write letters. It is an object of study in computer literacy courses. It can be a problem-solving tool for students calculating statistics, searching databases, or writing essays. All these are valid and thriving applications of computers in education. But they are not examples of CAI. In computer-assisted instruction, the student interacts with a computer program designed to impart knowledge, skills, and attitudes in some specific subject area. The interaction is not with the computer so much as through the computer. Just as a person reading a book is in communication with an author, not with the paper or the printing press, in CAI the learner's interaction is with the person or group of people who develop instructional programs. The range of topics and methods is as wide as the curriculum itself. Wherever teaching or textbooks or other media are used to deliver instructional messages, the computer could be used to deliver the same message.

What is the CAI dilemma? First, is there a shortage of educational software? The answer is both yes and no. Because most brands of microcomputers are incompatible with one another, the selection of educational programs varies considerably from brand to brand. Even among the software offerings for popular computers, the range of educational software is very uneven. There is an abundance of simple mathematics drill and practice programs, but a dearth of programs using other techniques such as tutorials and simulations. Despite the number of educational programs available commercially, it would be almost impossible for a teacher to find any program or series of programs whose scope and sequence matched the curriculum. As a result, the computer cannot be used on a daily basis to provide individualized instruction. The few exceptions to this statement are some college level courses developed on large computers in the 1970s, but these are found in only a few institutions.

A second aspect of the problem relates to the quality of the available software. Often, the public-domain materials donated by dealers and user groups are the first pieces of software that teachers and learners use. These are almost always of poor educational quality. Unfortunately, many educators derive their first impressions of CAI from these products. Some of these programs don't operate in a user-friendly manner, and some don't operate at all. Few of them come with printed support materials summarizing the content and instructional method used in the program and suggesting how the program could be integrated into the class. Until recently, few software packages were written by educators or designed to use systematic instructional procedures.

Fortunately, an active educational software industry has developed in the last five years. The technical quality of the software has improved, although this improvement is sometimes limited to flashy graphics and arcade games used to camouflage and sugar-coat unimaginative lower-level drills. Nevertheless, some innovative and educationally valid software is emerging from small companies, many of them formed by educators. The image of the learner implicit in these new programs is one of a self-directed, problem-solving person. These developments are promising, but their effects are still only sparsely dispersed across the curriculum.

The source of the CAI dilemma is our poor understanding of the role and effect of instructional communications in education. Of all forms of human communication, instructional communication is perhaps the most complex. It is the act of extracting the essential elements from a universe of knowledge, representing these elements as a message in some communication medium, delivering this message to another person, and determining whether that person not only received the message but somehow changed as a result of receiving it. That change is what we call learning. Learning involves the assimilation of the message into existing cognitive structures and the reorganization of the cognitive structures to accommodate the new information.

This definition of instructional communication does not refer specifically to CAI, nor does it refer specifically to classroom instruction. It is a description of the teaching act. But because it is the most visible and dominant form of instructional communication in our present educational system, we tend to equate classroom instruction with teaching to the exclusion of other modes of instructional communication. Classroom instruction was not always the most visible or dominant form, however, and it will not necessarily remain so.

Classroom instruction developed in the eighteenth and nineteenth centuries, when the most efficient means of delivering instruction involved the grouping of a number of learners around a teacher. The size of the group was dictated by the constraints of two-way oral communication. When the industrial revolution, urbanization, and universal education led to larger groups of students, they were subdivided and placed in separate rooms so as to reduce the noise from other groups. Chronological age was used as the basis for forming the groups, and progress through the curriculum became group-dependent. These obvious characteristics of classroom instruction are described simply to point out that they are not innate properties of learning or instruction; they are the historical product of one means of instructional communication. Another form of communication, given two centuries, undoubtedly would generate different structures. That classroom instruction still thrives is an indication of its resilience and of the other non-instructional functions that schools provide.

Computer-assisted instruction is not something that is separate from teaching: it is one form of teaching. The people who write CAI programs are also teachers. They are successful teachers if the intended learning takes place as a result of the student's interaction with them through the program. Other forms of instructional communication, such as television, textbooks, and classroom instruction share the same criteria and goals. They are all embodiments of the teaching act. CAI can be compared and contrasted to other forms of teaching; in fact, it could replace or accompany those other forms. If it were fully developed, CAI could conceivably replace classroom instruction. But, when faced with alternate forms of instructional communication in the past, the educational system has rarely adopted them; more often, it has altered or ignored innovations that implied a substantial move away from classroom instruction. Thus, film, radio, and television, which revolutionized communications in the rest of society, have had virtually no significant impact on instruction.

These observations are not intended as a criticism of education. There may be positive reasons for maintaining classroom instruction as the principal form of instructional communication. The point is that the failure of CAI to have an impact on education may be due not to any inherent weaknesses in CAI but to the institutionalization and domination of a competing communication form that has successfully survived in the face of other technologies. But, some would argue, why not have both CAI and classroom instruction? The answer is that both CAI and classroom instruction are complex, labor-intensive activities. Furthermore, each requires a different institutional structure to support it. It would be too expensive to maintain two systems that perform the same task. It would make sense to replace the less effective and/or more expensive form with the more effective and/or less expensive form. Here we arrive at the uncomfortable part of the answer: computer-assisted instruction can, in general, be more effective and less costly than classroom instruction.

CAI can be more cost-effective than classroom instruction for the same reason that any technology can be more cost-effective: the collected labor and knowledge of many people are focused on the one task. The learner in a CAI lesson benefits from the efforts of many teachers, programmers, subject experts, instructional psychologists, graphic artists, and writers. Hundreds or even thousands of hours have gone into the preparation of the lesson. The lesson is replicable: it can be distributed to an unlimited number of learners. The lesson is revisable: its effectiveness can be monitored and it can be improved until it reaches a specified criterion. An individual classroom teacher may be inherently superior to educational software, but that individual's instructional communication with 30 or so classroom students is not replicable; it is only repeatable and then only within severe limits of time and space. Because of the ephemeral nature of the spoken word, that communication is not easily revised. Finally, classroom instruction depends primarily on the labor of one person, the teacher, who must exercise abilities in a variety of areas including subject matter, teaching techniques, learning theory, classroom management, test construction, and oral communication. It is no wonder that teaching is such a complex and demanding task. It is also no wonder that the performance of the task varies considerably from teacher to teacher, since it is linked so closely to the person.

There are instances where higher technologies are not more effective. CAI is not cost-effective with a small number of learners. The hundreds of hours of development time needed for one hour of instruction cannot be justified for a handful of learners unless the computer is capable of providing something that other media cannot provide. For example, computer-based flight simulators make sense because of the types of experiences they can offer even if the number of pilots trained is relatively few. CAI is also likely to prove ineffective if other components in the educational system are not in place to support it. For example, because it is a form of individualized instruction, CAI does not support and is not enhanced by a system that groups learners by chronological age beginning in September and ending in June. For another example, if CAI were fully implemented, the majority of learners could complete the elementary and secondary curriculum in eight years if that curriculum did not change, a factor that would have a serious effect on the social and other functions provided by the school.

It is a truism that the introduction of a new technology has effects that range far beyond the initial problem it was designed to solve. Under its impact old institutions adopt new procedures, take on new roles, or simply fade away. Sometimes new technologies produce new institutions. Competing technologies sometimes coexist or complement one another, particularly during the transition period when one technology is replacing the other. Wind-driven ships were not replaced by steamships overnight; indeed, the first steamships carried sails in case the new technology failed. Furthermore, sailing ships and sailors did not disappear, although their roles and functions changed dramatically. If shipping had been equated with wind energy and sails rather than with the transport of goods and people, sailing ships would still dominate the oceans.

It can be difficult to entertain the thought of using different means to reach an end when the means for reaching it have become too closely identified with that end. The new means may seem threatening because the changes they imply can be confused with changes in the purpose or goals of the system itself. This is the inherent conflict in using both CAI and classroom instruction. Because the educational system equates classroom instruction with teaching, other forms of instructional communication are rejected or relegated to serving as aids to support classroom instruction rather than to carry the entire instructional process. There is a shortage of CAI because the institution that should provide it has been shaped by the effects of classroom instruction to such an extent that full implementation of CAI could not be supported without drastically changing the institution itself. As a result, we see scattered uses of single CAI programs designed to provide remediation, enrichment, and variety as supplements to "regular" instruction.

If this analysis is correct, the solution to the CAI dilemma is not simply a matter of placing more computers or software in the schools; what is needed is a change in perspective. First, there is a need to re-emphasize that, regardless of the form instructional communication may take, communication itself is a human process involving a minimum of two people, a sender and receiver, who continually exchange roles while interacting. In instructional communications, the sender and the receiver are the teacher and the learner. Other people may enter the process, particularly as it becomes more technologically complex; but the teacher and learner roles remain, although they may no longer be identified with individuals. Second, there must be a disentanglement of means and ends so that the goals of education are not necessarily associated with the present means of reaching them - that is, the grouping of learners into age groups whose size and environment is determined by the constraints of oral communication. Third, it must be recognized that different forms of instructional communication require different institutional structures and that the cost of adopting new technologies includes the cost of changing these structures. Finally, educators need to change the image of their role in the education process. The person who designs a CAI lesson that results in the desired learning taking place is as much a teacher as the person who delivers that lesson in a classroom. Whether these two people are equally effective is another question. What is more important is the fundamental change in perspective that recognizes the central place of teachers in instruction but that opens up the instructional process to other forms of enacting the teaching role.

Without this change in perspective, CAI and other instructional technologies will continue to play a minor role in school-based education. Meanwhile, schooling will become more anachronistic as the society around it continues to evolve and adapt to new technologies.

THE THORNY QUESTION OF SOFTWARE

By Louise Dubuc
Québec Ministère de l'Education

The development of the microcomputer has attracted attention because of spectacular advances in the hardware industry. Computers first miniaturized themselves, then multiplied themselves, and finally became so common as to gain entry into the classroom.

Remarkable as these successes are, one detects a feeling of incompleteness. In spite of their increased power and the promises of friendly dialogue with them, the computers still stutter or maintain only limited conversations with their human interlocutors.

This situation is particularly flagrant in the field of education. One sees more and more microcomputers in the schools of industrialized nations, but most of them are reserved almost exclusively for the teaching of computer science and programming because there is so little software available in the other disciplines. This is not, however, because no one complains of the scarcity of software; everyone does so. It is as though a certain reticence prevents program designers from venturing on to the path of educational software. If this situation is not redressed, we may well witness the progressive disaffection of most teachers and the use of the computer reserved more and more for computer specialists only.

This prospect leads us to ask how we might protect ourselves from such a future. There is but one solution: we must increase the amount and the diversity of educational software. But by what means can we arrive at this development?

The axes of software development

The pedagogical relationship is traditionally schematized as a triad grouping of content, teacher, and student. Let us use this as a basis to see if these elements can be the points of origin of three axes of software development.

Content

Content is the first element that comes to mind because it seems the simplest to study. Unlike the other two poles of the relation, it does not oblige the inquirer to envision simultaneously all the components of human personality and to take into account their incessant interaction. At first glance, content appears to form a well-defined whole of relative stability.

Because of these characteristics, it ought to be simple enough to develop software with respect to this pole. It would suffice to perceive adequately the essence of the content, to understand separately its minute components, and to grasp their network of relations. One could thus describe a complete tree of knowledge whose branches would practically define the paths of learning to be adopted.

Curiously, this axis of development does not reflect the anticipated simplicity. First, few of us can boast of knowing intimately all the aspects of even one academic subject, let alone that of a field of knowledge. Such total comprehension would require monumental effort. It presupposes that one has explored each facet of all the concepts that constitute the field as well as every relation that positions them, each with respect to the other. Furthermore, really understanding a field is to be sufficiently permeated by it to seize at once the details and the whole. Therefore, it is far from being a simple matter.

The premise of simplicity also becomes debatable when one stops to think about the state of science. For the majority of disciplines, the body of knowledge constitutes an imposing edifice. That does not mean that science is stable; far from it. Science evolves constantly and its contours are in a flux of perpetual redefinition. Every day, new discoveries force investigators to rethink their practice; sometimes, brilliant discoveries are made by great thinkers and bring radical paradigm changes to the whole scientific community. Moreover, contrary to the comforting idea of a well-constructed edifice, science is neither completely elaborated nor totally determined. It resembles more a moving tissue of innumerable certitudes and hypotheses in which holes of ignorance and of the unexplained may be discerned. The missing link in anthropology, etiological unknowns in medicine, and the fragility of sociological laws of human behaviour critically demonstrate this.

Because of the difficulty of acquiring knowledge and because of the imprecision of the objects of discovery, it is difficult to develop educational software relying only on content. These, however, are not the only reasons for hesitation. The main reason for doubting this option is that the content is not at all equivalent to the content-to-be-learned. It is pure rhetoric to portray science as independent of those who communicate it and appropriate it to themselves. Things and phenomena exist independent of persons, but science itself exists only through our capacity to search for explanations.

The teacher

One might suppose that the second pole of the triad - the teacher - offers a more fruitful source of inspiration for software designers. Educational theorists have long analyzed teachers' behavior and abundantly described their practice. Psychologists have offered numerous techniques to help them stimulate learning. Educational technologists have explored in depth the total system in which they evolve and have brought to light the conditions their environment should meet for their teaching to be effective.

In any case, it is not at this pole that the software designers will find an immediate model to guide their input into the computer. The greater part of the pedagogical literature is focused on human teachers and virtually ignores the other media that could serve as conduits of knowledge. Human intervention is profoundly distinct from mediated treatment.

When a teacher deals with a student, both can play on several registers at once - the cognitive and affective registers, for example. Moreover, each immediately perceives the totality of signs (oral, written, gestural) that emanate from his or her interlocutor. It is thus a transaction of maximum semantic density and complexity that teaching manuals describe. The computer cannot be programmed to act as a vehicle for such a richness of concomitant signs.

Not only does the pedagogical literature tend to blur the mediation phenomenon, it often disregards the content to be transmitted. This approach has the advantage of extracting the actions common to all teaching disciplines. Conversely, the insistence on pedagogy brings with it a disadvantage: it tends to overshadow the "didactics," the only discipline to combine the examination of a field of knowledge with a serious study of the techniques that effectively transmit its specific content.

Finally, the literature on teaching often neglects the fact that teacher and student experience the pedagogic relationship at the same time. The action of the teacher and that of the student are singularly contemporaneous in the classroom and do not suffer the ineluctable time lag between the programming of a course and its delivery by computer. There is a significant difference between deferred teaching and real-time teaching.

The effect of these last two points is that teaching manuals never describe to the programmer the actual transmission of specific subject matter, nor indicate how the software could imitate the instantaneous contact (hic et nunc) that is established between teacher and student.

The student

It appears risky to base software development on the content or the teacher. The former brings with it too many shadowy zones; the actions of the latter have not yet been sufficiently elucidated to be coded into a machine. The danger is perhaps less great if we approach the problem from the direction of the third element of the triad: the student. This last direction possibly presents more solid ground. If the knowledge of the expert and the experience of the teacher are not available to each of us, we can at least all boast of being perpetual students and thus of being in a position to scrutinize the way we apprehend things.

Despite a certain air of familiarity, however, the pole of the student is also surrounded by mystery, if only because the "student" archetype masks reality. With respect to a given learning task, there is never a homogeneous group but rather a plethora of individualities distinguished by their cultural and scientific backgrounds, cognitive styles, talents, levels of intellectual development, or any combination of such differences. This is the first mystery. The software designer will always be confronted with a composite public that is all the more difficult to encompass because no typology of learners will permit a confident categorization of each individual of any target population.

The diversity of students' ways of learning constitutes the second mystery. Many theoretical approaches offer their various laws of learning. The assumptions they contain are attractive enough to support a certain following. We adopt behavioristic explanations without much hesitation because it is true that learning can be induced by operant conditioning. The discoveries of cognitive psychology are accepted with the same ease because learning can also result from sudden inspiration (insight). But diverse demonstrations will convince no one totally so long as no system can explain with equal power all the various forms of learning. However chastening it may be felt, the best we can do is hope for the emergence of a definitive, unified theory.

The system

None of the elements in the pedagogical relation constitutes by itself a final answer to the problem with which we are faced: how to approach the development of educational software. There is nothing surprising in this. The examination of individual elements of the triad makes analysis possible, but remains an artifice that hides the connections between the elements and says nothing about the fact that the whole is greater than the sum of the parts. Yielding to this approach, one abandons a holistic point of view and drifts little by little toward a reductionist vision of things.

But if we consider the entire system - the content, the teacher, the student, and their relations - instead of the elements, can we be sure we will arrive at a solution to the problem? Nothing is less certain. The relations among the elements are just as difficult to decipher as the elements themselves. Though we know they exist, we are unable to name or characterize them. As for the totality of the system, it is composed of so many unique situations that its complexity defies any encompassing perspective.

Conclusion

In the face of such arguments, one might be tempted to abandon the project before it is even begun, and to conclude that it is not worth the effort and the risk to develop educational software. Such a conclusion is patently unacceptable.

If these thoughts seem to lead to an impasse, it is because the problem is badly framed. The key to software development is to consider the problem as one not of theory but of action.

We need educational software. We need it at every point where schools are currently having difficulty in fulfilling their role. The nodal points of difficulty are many.

Certain disciplines are badly served by existing teaching materials. Such is the case, for example, in disciplines for which learning requires much laboratory work. A great many computer simulations would be appropriate here. Certain pedagogical functions demand more time than a teacher can provide. Special education and programs for the gifted are examples of this; drill and practice programs, corrective exercises, and tutorials could be extensions of the teacher. Certain learning activities are tedious in their traditional form, while others would be considerably enriched by more adequate tools for intellectual work. Various software programs could contribute to answering this need.

It is widely observed, for example, that learning the written language is unpopular with students. They resist this study so intensely that even at the university level their spelling and syntactical skills are insufficient to allow them to communicate properly. To overcome this obstacle, more and more teachers are using word processing software to help students improve their writing. If placed in group projects that motivate them (classroom journals, school plays, or adventure stories), students soon discover the benefits of a language properly mastered. Teachers of mathematics apply the same reasoning when they use electronic spreadsheets to help students realize the necessity of using basic mathematical concepts correctly.

Research projects provide another example of an area where powerful software has a role to play. Data-gathering, filing, and retrieval are activities that have traditionally discouraged students. Given software capable of accessing data banks, data manipulation becomes an opportunity for discovery that students will no longer shy away from.

Overcrowding is perhaps the greatest problem encountered in the classroom. Confronted by classroom sizes that vary from thirty students in primary grades to a hundred or more in secondary grades, the teacher is unable personally to help or even follow with any regularity the progress of individual students. Computer-managed instruction programs minimize this problem and thus render great services in the classroom.

In the context of action, therefore, useful ideas are not lacking on how to approach the scarcity of classroom software. The path of development is easily outlined: it is to overcome the previous difficulties in order to give the student the best context for learning. And if we are assailed by doubts when the problem to be analyzed leads us insidiously toward the distressing gaps in the science of education, let us remember one important axiom: our progression must be founded on empiricism and driven by creativity. Whatever else we may think about it, learning remains magical. Then why not wish to see programs become thaumaturges?

PLANNING FOR TECHNOLOGICAL CHANGE IN POSTSECONDARY INSTITUTIONS

By James A. Humphries
Grant MacEwan Community College

Today there is virtually unanimous agreement that we are living in an age of rapid technological change. Cars, industrial machinery, and even appliances contain microprocessors that control processes, monitor systems, and instantaneously provide information to the operators. Consumer electronics is a whole new industry; microprocessor-based toys and games, digital watches, wrist-radios, and even wrist-televisions are all widely available. Businesses are using microcomputers for financial management and word processing tasks.

Educational institutions also have acquired technology at an unprecedented rate. Administrative personnel perform scheduling tasks and access information pertaining to students, faculty, registration, and finance. Libraries and learning centres offer terminal-equipped carrels and computerized research systems. Computer-assisted instruction (CAI) and computer-managed instruction (CMI) enhance the learning process, and many institutions offer programs in computer- and technology-related areas.

The most important technological issue in postsecondary education is institutional planning. Failure to coordinate the acquisition and use of automated instructional and support media can result in chaos. This paper examines some of the problems resulting from unplanned acquisition, and offers some concrete suggestions for avoiding these problems.

One major problem that arises from lack of planning is the proliferation of hardware systems, especially computers. If different departments in an institution obtain different types of computer equipment, the risk of incompatibility is a serious one. Software programs that run on one system often cannot be run on another without great difficulty. Indeed, it may not even be possible to share information of interest to two users because of data-storage media incompatibility. And, if hardware is not properly chosen, users will be unable to have their units "talk" to one another, and will be prevented from sharing one another's computing resources.

A second potential problem is obsolescence. Rapid innovations make systems technologically obsolete almost as soon as they are delivered. Practically speaking, two or three years seems to be the useful lifetime of most systems. If no plan has been developed to relocate the used systems within the institution to meet other needs, two alternatives are left: shelve the systems or sell them for their salvage value.

Under-utilization is also a concern. Once the "new toy" effect has worn off, faculty may be reluctant to continue using new equipment if they lack technical knowledge or access to it. The same problem may result from failure to consider fully the implications of curricular integration; new technology cannot merely be inserted into an existing course without prior thought having been given to what objectives it is meant to fulfill and how.

A final problem has to do with the determination of the real cost and benefits of educational technology. There is little difficulty dealing with capital acquisition costs, but when it comes to demonstrating corresponding educational gains in terms of dollars, decision makers are sometimes left groping.*

Within postsecondary institutions, a number of things can be done to alleviate these four problems and to ensure efficient and effective use of instructional technology. Inherent in all of the following suggestions is the assumption that technology is not the final solution to all

---

* Fielden, however, has a solution to this dilemma. He suggests a five-phase approach to performing a cost-benefit analysis for educational technology. These phases include identification, decision, measurement, and data collection, analysis, and presentation. Fielden's thorough and flexible method involves a differentiation between instructional outcomes and qualitative benefits, and deals with expenditure reductions, time savings, and investment appraisal techniques such as payback period and net present value.[1]

educational problems, but rather a significant step toward solutions. Programming, procedures, instructional sequences, and methodologies must all proceed from a clear understanding of goals and objectives. Technology will be involved, of course, but not necessarily in all facets of the instructional endeavor.

- Be prepared to have some traditional assumptions about learning, instruction, curriculum, and even administration severely challenged. New vehicles for imparting skills and knowledge demand new approaches.

- Survey the existence and use of technology within the insitution. Is there a possibility of expanding the use of current systems?

- Establish an institution-wide committee responsible to the president for making recommendations on the coordination, integration, and compatibility of further technological acquisitions and for sharing information about them. It is essential that an instructional officer be a participating member of this committee.

- Identify capital-intensive instructional programs and their current inventories. Then, with reference to instructional goals and objectives, make a detailed five-year financial plan that allows for scheduled replacement of capital items on inventory. Keep government funding officers aware of these plans.

- Develop and implement a long-term, in-service training plan, especially for the computer area, that includes the president and executive officers. The in-service training must incorporate a significant amount of hands-on work; that is, participants must actually use the computer systems. Being aware of specific instructional needs is complementary to, but quite different from, knowing what technology is available to meet those needs. The skills, knowledge, and attitudes developed during the initial planning stages will form the building blocks for future, broader planning efforts.

- Provide significant incentive funds for special faculty-initiated projects. Innovative uses of computer software and audiovisual instructional media will always be in demand, especially if they are developed in response to a specific need.

- Negotiate price reductions with hardware manufacturers. Three-for-one and two-for-one deals have been available for limited periods for several years. Some manufacturers may be interested in establishing a "model site" within the institution to show off their software or hardware.

- Consider requiring students to purchase microcomputers and appropriate software. Printers for producing hard copy could be installed with strategically located microcomputers at the institution. Some manufacturers are willing to negotiate institutional lease-purchase agreements. In the future, governments may provide additional money through loans and grants.

- Consider installing desktop microcomputers and local area networks for administrators. The microcomputers can be used for functions such as budget preparation, word processing, and handling of other types of administrative data. Local area networks enable all microcomputer systems in the network to exchange information among themselves or to access institutional files resident on a host minicomputer or mainframe. The local area network can also be used for the sharing of information that seems to waste so much valuable time at meetings.

Undoubtedly, some of these suggestions, if implemented, will be costly. If properly planned for over a number of years and examined in terms of expected outcomes or future educational benefits, however, the expenditures will be justified. And, to paraphrase an original technologist, Commodore Grace Murray Hopper, the key question is not "How much will it cost if we do it?" but rather "How much will it cost if we DON'T do it?"

NOTES

1. Fielden, J. "A Way of Costing Educational Technology." Journal of Educational Technology Systems. Vol. 12, No. 2, 1983-84, p. 203.

EDUCATIONAL TECHNOLOGY

By Denis Hlynka
Faculty of Education, University of Manitoba

The field of educational technology has developed as a series of movements, sometimes related, but more often discrete. The evolution of educational technology in Canada can be summarized as follows:

1920s Introduction of "visual education" and field trips

1930s Educational films; Educational radio

1950s Educational television

1960s Programmed instruction

1980s Microcomputers and new information technologies

Paul Saettler suggests that there are two distinct approaches to the discussion of educational technologies.[1] The first, a physical science perspective is "essentially a hardware approach, stressing the importance of teaching aids, and its origin lies in the application of physical science to the education and training system."[2] The physical science definition, sometimes called technology <u>in</u> education, presents the audiovisual viewpoint. Technology is synonymous with the machine and the value of the machine in improving human efficiency. While, historically, the audiovisual field was a 1940s phenomenon, there is nevertheless a strong component within the contemporary computer revolution, as evidenced by those who find most interest in computer hardware, compatibility issues, and by those who look forward to the 'bigger and better' machines.

The second, a behavioral science view, "is essentially a software approach, and refers to the application of learning principles to the direct and deliberate shaping of behavior."[3] In this model, the focus is on a technology <u>of</u> education. Here, the specific medium takes second place to a systematic, define-develop-evaluate paradigm. First, the needs and audiences are defined; second, an appropriate medium is selected; third, the resulting product is evaluated.

Davies carries the Saettler approach one step further and suggests a third, more systemic, gestaltic, holistic, or artistic approach which is rapidly becoming the focus of the 1980s.[4] The systemic view proceeds from the limitations of the systematic approach, so often criticized as being cold and dehumanizing, and places stress on the management of learning within a heuristic decision-making framework. Thus the systemic definition of educational technology contains all the systematic elements, but adds an individual - and therefore human - dimension to what educational technology is all about.

With the introduction of each new technology, researchers were extremely active in studying the comparative effectiveness of the various media: they hoped to find the one best "master" medium. Inevitably, the studies showed that there was no "best" way of teaching. Film was as good as any other medium, and so was television. Today, we seem to need to repeat the exercise, substituting the latest medium, the microcomputer. The most appropriate summary of this situation is the classic understatement of Wilbur Schramm. He referred to the results of his work on television, but any other educational medium might equally well be substituted.

> "No informed person can say simply that television is bad or that it is good for children. For SOME children, under SOME conditions, SOME television is harmful. For OTHER children under the same conditions, or for the same children under OTHER conditions, it may be beneficial. For MOST children, under MOST conditions, MOST television is probably neither particularly harmful, nor particularly beneficial."[5]

The 1980s saw a new technology burst forth on an unsuspecting world with the invention of the microchip, which changed large, bulky, ponderous computers into small, slick, and extremely fast microcomputers. And the microcomputer was only the first of what became a series of new technologies destined to implant themselves into society and into education.

What are the new technologies and what is their impact on education? That question is a major concern of educators and technologists around the world. In the literature published before 1980, it is virtually impossible to find reference to the keywords, communications and information technologies. In books and journals published after 1980, the references come thick and fast. Three examples are offered here:

- The fourth edition of the notable De Fleur/Ball-Rokeach text, Theories of Mass Communication (1982), devotes a chapter to "emerging media systems," described as "if not themselves candidates for mass media of the near future, (they will) most probably lay the foundations of the emergence of new media systems."[6] The technologies identified are computers, cable television, and communication satellites.

- Probably the first book to explore the educational implications of the new technologies is Hawkridge's New Information Technology in Education,[7] which deals with three specific technologies - computers, videotex, and videodisc.

- A most useful document is the American Corporation for Public Broadcasting's Telecommunications Technologies and Public Broadcasting.[8] This report considers 14 technologies: teletext, videotex, specialized cable, interactive cable, videocassettes, teleconferencing, microcomputers, high-definition television, low-power television, subscription television, multipoint distribution services, digital audio, subsidiary communications authorization, and direct broadcast satellites.

Research on the educational potential of the new technologies is not lagging. However, in any attempt to assess the future, the "bottom line" must be a response to the key question of whether or not educational technologies improve learning.

- Joseph Rakow in The Audiovisual Myth in America[9] identifies four myths and demonstrates their pervasive power. These myths are: first, that traditional methods of instruction are inherently bad; second, that instructional media are the solution; third, that the content conveyed by the media is precisely the content of greatest value; and fourth, that traditional methods of instruction and instructional technology methods are mutually exclusive. An exploration of these myths in relation to the new information technologies should be undertaken.

- Anthony Oettinger and Nikki Zapol, in Will Information Technologies Help Learning? conclude that "There is a growing realization that it is hard to perceive learning needs adequately, hard to assess the value of technology for learning, and hard to deploy people, processes, and tools effectively...Our analysis shows that how technology can help learning is a far more complex question than most discussions of the subject have taken it to be."[10]

- John Lee's Mentors and Monitors: Mass Media in the Canadian Classroom offers a post-mortem of a unique attempt to design a complete college "for the extensive use of television teaching in its classrooms and laboratories."[11]

- Elsewhere I have described some of the other key documents that deal with this question.[12]

It is not my intention to recommend that educators shy away from the new technologies. However, the full-scale adoption of half-developed ideas will not further the advancement of either education or technology. It can be argued that none of the older technologies has had a significant effect on education. If all film projectors or all television sets were to be removed immediately from classrooms, few teachers or students would notice the difference. And yet, both film and television have made a major impact on society as a whole. Is the same true of the computer revolution? Will its societal impact be far more profound than its classroom impact?

Thomas Ed[illegible] his enthusiasm, once predicted that "In ten years, te[illegible]s as the principal medium of teaching will be as obsole[illegible]s the horses and carriages are now...Visual education, the imparting of exact information through the motic[illegible] picture camera, will be a matter of course in all our schools."[13] Edison was wrong about the motion picture camera. Will computers "become a matter of course in all our schools?" Will the new information technologies improve learning? As of this moment, the unsatisfactory answer is that we simply don't know.

NOTES

1. Saettler, Paul. A History of Instructional Technology. New York: McGraw-Hill, 1968, p. 1.

2. Davies, Ivor. The Management of Learning. London: McGraw-Hill, 1971, p. 5.

3. Ibid., p. 7.

4. Davies, Ivor. "Educational technology: A context for theory-building in the 1980s." Resources in Context. Proceedings of the AMTEC '82 conference. Winnipeg: Association for Media and Technology in Education in Canada, 1982, p. 2-12.

5. Schramm, Wilber; Lyle, Jack; and Parker, Edwin. Television in the Lives of Our Children. Stanford, Calif.: Stanford University Press, 1961, p. 1.

6. De Fleur, Melvin L. and Ball-Rokeach, Sandra. Theories of Mass Communication, 4th ed. New York: Longman, 1982, p. 101.

7. Hawkridge, David. New Information Technology in Education. Baltimore: Johns Hopkins University Press, 1983.

8. Corporation for Public Broadcasting. Telecommunications Technologies and Public Broadcasting. Washington: Corporation for Public Broadcasting, 1984.

9. Rakow, Joseph. "The Audiovisual Myth in America: Filling the Cracks of Educational Technology." Journal of Education. Vol. 162, No. 8, 1980, pp. 34-54.

10. Oettinger, Anthony, and Zapol, Nikki. "Will Information Technologies Help Learning?" Teachers College Record. Vol. 74, No. 1, 1972, pp. 5-53.

11. Lee, John. "Mentors and Monitors: Mass Media in the Canadian Classroom." Communications in Canadian Society. Toronto: Copp Clark, 1975, p. 104.

12. Hlynka, Denis, and Hurly, Paul. "Correspondence Education and Mass Media: Some Issues and Concerns." Programmed Learning and Educational Technology. Vol. 19, No. 2, 1982, pp. 158-165.

Hurly, Paul, and Hlynka, Denis. "Prisoners of the Cave: Can Instructional Technology Improve Education?" Proceedings of the Fourth Canadian Symposium on Instructional Technology. Ottawa: National Research Council of Canada, 1983, pp. 231-8.

13. Weir, H. "What Edison Would Like to Do with the Movies." Colliers. Vol. 75, No. 8, 28 February 1925, pp. 20-21.

INTEGRATION AND INTELLIGENCE

By Michel Umbriaco
Télé-université

Integration and intelligence, crucial themes in any examination of the new technologies in education, are constantly expanding concepts. Some of the current experiments in the integration of technologies and in the expansion and replication of human intelligence are indications of future reality. Using the results of these experiments to create a desirable scenario for the future is not strictly an analytical exercise. Instead, it requires a balance of ethics and imagination, of values and discourse, of present needs and future planning. In this paper, a view of the present socio-educational context is presented, some of the impacts of the new educational technologies are considered, and the desirable values connected with the introduction of technologies in education are outlined.

Socio-educational context

New technologies in education have been the subject of so many reports, articles, and commentaries that a comparative analysis of the socio-educational context in which they are introduced becomes hazardous if we do not first clarify our own values. A brief discussion of some of the elements in that context follows.

- Western economies have recently been characterized by strong growth without corresponding job creation. The percentage of the population who are employed has been decreasing since World War II. Some authors forecast an acceleration of that decrease in the next 10 years owing to mechanization, robotics, and electronic offices.[1] Others even propose a new way of looking at formal paid work versus an informal economy of creative occupations.[2]

- The population in Western society, including Canada, has been aging since the 1950s. This will continue to have important effects on education, health care, and the economy in general.

- Technological progress is an evolutionary process, a reconfirmation of the past rather than a revolutionary movement. The Western and Canadian social parameters will be little altered by the introduction of new technologies unless we implement purposeful changes. Some aspects of the new technologies may actually facilitate changes. The current tidal wave of information and knowledge is fundamentally altering the traditional distinctions between fields of study; we even speak of foreseeable obsolescence in some sectors of knowledge. This reorganization of knowledge encourages continuity and interrelations rather than the traditional compartmentalization inherent in the unique subject approach. In addition, technological development is leading to the computerized integration of media which, in turn, will be greatly affected by the advent of fifth-generation "intelligent" computers. This technological innovation may permit the creation of expert systems and more "natural" interfaces between humans and machines.

- Technological change brings with it the establishment of a new set of values aimed at changing some of our Western paradigms. These new values favor humanism and an active individualism that may be characterized by:

  (a) magnified or, alternatively, reduced confidence in large organizations, such as corporations, governments, and unions;

  (b) increased importance of small-scale work performed by the individual with a consciousness of his or her place in the larger community;

  (c) accelerating awareness of the social, cultural, and biological environment.

- Education in Canada is a provincial matter. Canadian regional and provincial disparities in the economic, socio-cultural, and educational sectors may complicate some developments; from the national point of view, those disparities have many disadvantages. However, they also have the immense advantage of favoring democratization, decentralization, local authority and responsibility, and the beginning of pluricultural dialogue.

- Technology, old and new, is relatively little used in the formal educational system, which remains widely structured around a person-to-person relationship between a teacher and a student. An exception to this is distance education, but even there reliance is still placed on the book as the primary medium for course delivery.

- Finally, how do we actually perceive education? The educational process is continuous and permanent. Teachers, technologies, and educational systems are regarded essentially as tools that can either help or hinder an individual who seeks a coherent interface between himself or herself and an expanding universe of knowledge.

Impacts of new technologies in education

Technology provides a high degree of accessibility to knowledge. This accessibility has been reinforced by the spread of microcomputers - powerful and relatively simple tools, both affordable and useful. However, accessibility and a willingness on the part of students to use these technologies are curbed by the difficulty of changing people's attitudes and by the disappointing quality of available software. We seem to be caught in a vicious circle; there are few users because there is little relevant software and there is little relevant software because there are few users. None the less, technologies should and will be progressively integrated into education, particularly in distance situations. It is important to remember that the interaction between two humans that takes place in a face-to-face learning situation has not been replaced or eliminated.

Technologies are powerful tools, and their power is increased by integrating them. Further developments can be expected as a result of current research and development on increased integration and the coming of the expert system, which will be able to simulate more and more closely the human reasoning process. In effect, the first major impact of technology in education is to stimulate further possibilities for testing and potential development.

The second major impact may be in the application of the principle of "more and faster." The new and very fast technologies are already being used as tools of intellectual productivity for saving time in research and in the sharing of information. That impact is positive if the time saved allows individuals to enrich their face-to-face interactions.

The relative share of financial resources for education in Canada, as in many countries, has been stagnating or declining for some years. The current high costs of technology have an impact on the funding as it will be difficult, in these conditions, to invest sufficiently in the production of necessary and relevant learning materials. This tightening of finances may also cause the technophiles to advance ideas of increasing productivity and cost-effectiveness through the use of these technologies. That kind of rationalization may cause a negative reaction, leading to rejection, on the part of the technophobes.

Another major impact relates to the credibility that may be attributed to the system itself. A centuries-old debate exists between the power of knowledge versus critical intelligence. In the terms defined by Michel Serres,[3] the purpose of intelligence is creativity, and the purpose of knowledge is power and security. If the system indeed becomes credible, and if it is believed when it "speaks," then it may be useful in the imparting of knowledge, but not in the encouragement of intelligence.

Still another impact is the possible simulation of teaching by the new technologies. This may be most useful in distance education or in training large numbers of people in a short time. Some surveys of successful distance institutions demonstrate two common elements. The first is that they do not use any one medium or technology as the sole support for a learning activity. Instead, they rely on the synergy of several technologies. Second, they provide contact between a tutor and small groups of students. Some research seems to show that only 30 per cent of the adult population in universities are capable of self-teaching with only the aid of media. The large majority of adult learners need a human contact whose feedback may vary from simple encouragement to explanations that are very close to traditional teaching.

These major impacts, present or foreseeable in the near future, require us to choose whether or not we wish to act to curb or to amplify some consequences of the new technologies. To do this, we must define what is desirable.

Desirable values and challenges

When we live in a time of transformation, we must rebuild the future. This enterprise cannot succeed unless it is conducted with serenity and without panic. Socio-cultural changes never happen suddenly, and by developing information technologies with care we will be taking into our own hands the responsibility for our creations and our choices. Such planning can be based on two values that signify the positive and harmonious development of people and a balance between the concerns of the group and those of the individual. The first of these is increased autonomy in education. The individual should be able to use intelligence, knowledge, and imagination to assert his or her own power of learning. Second, an equilibrium between the individual's acceptance of responsibility for herself or himself and the acknowledgement of the group inherent in the concept of democracy should be established. In terms of technology, this means moving beyond user-friendly systems to networks and databanks that allow participation, communication, and interrelation between users. Human parameters must be taken into consideration in development so that new technologies not only are user-friendly but can be adapted to human scales. They must promote the decentralization of knowledge creation and propagation.

Bearing in mind these values, along with the socio-cultural context and the actual or predictable impacts of new technologies in education, three challenges for Canadian educators are highlighted. The first urgent challenge is, without doubt, the promotion of a pluricultural dialogue among educators, students, and employers. The second challenge relates to integration, both social and technological. The needs of people must be the priority in promoting participation and in preserving the cultural dynamic. This priority must be established even at the risk of prejudicing technological development. Integration can enhance the reconciliation of the divided approach inherent in anthropocentrism and technocentrism.

The third challenge is to restore intelligence as the dominant system that includes knowledge as a by-product. Doing so requires a vast process of combined research and action, well-founded on innovation, imagination, invention, and sharing.

Conclusion

We can assume that new technologies used in education will either have or not have desirable impacts, according to our ability to accept the challenges of their intelligent integration in the continuing and permanent educational process. These new, powerful, and promising tools should be the starting point of an era of incentive for pluricultural dialogue and for an era of increasing quality of education in Canada.

NOTES

1. Valaskakis, Kimon. "L'Education: demain," Science et Technologie. Vol. 3, No. 1, avril 1984.

2. Berghofer, D.E. Educational Policy Development in the Information Society. Toronto: Association of Canadian Community Colleges, 1982.

3. Serres, Michel. "La Haute Couture de la Connaissance," Autrement. No. 57, février 1984.

NEW CONNECTIONS BETWEEN TECHNOLOGY AND EDUCATION

By Sylvia Gold
Canadian Teachers' Federation

The new technologies run like a current throughout our lives. We have only to think of communications (including television and satellites), of computers (in banking and other consumer-related fields), and electronic manufacturing devices (such as robots) to get a sense of their power. The short-term and long-term potential of the present generation of technological development is awesome.

I propose to identify several issues that are part of the current educational scene and that will, in my opinion, continue to be major concerns in the future.

The case of the school drop-out is the first issue. Current Canadian estimates indicate that between 20 and 25 per cent of elementary- and secondary-school students become drop-outs. Formerly, the labor market could absorb significant numbers of young people who left school before acquiring the degree of literacy required to function in the trades or skilled occupations, but it cannot do so today. The undereducated youth of the 1980s require specialized upgrading services to help them fit successfully into society. Such assistance is necessary not only to enable them to become self-supporting but also to prevent their rebelling against an affluent society that appears to be shutting them out. This student group - older adolescents - may be prime candidates for service from private-sector educational interests. "Learn-at-home" software packages already are being developed specifically for young people who drop out of the formal educational system. Although schools have been concerned about the needs of the unconventional learner, they have not done well in serving them, and these learners may welcome private initiatives to help them.

The second significant issue is the situation of the female student and worker. Enrollment figures indicate that girls continue to select courses that prepare them for disappearing occupations and that they are far behind boys in enrolling in future-directed science and technology courses. Yet they will enter into and stay in the labor market in greater numbers, and more women will become self-supporting or sole-support parents. Leaving aside the cogent arguments for utilizing the intelligence of half our population and the satisfaction women, like men, derive from career progression, economic independence is reason enough for the education system to ensure that female students are enrolled in increasing numbers in technology-related courses.

A third major issue is the influence of employer groups. Historically, employers have lobbied for credentials and skill training. They were quite clear and rigorous about the skills they demanded in potential employees, from penmanship to punctuality. The education system must decide whether it can meet employer demands in the new context. When labor market requirements are changing rapidly, should secondary schools attempt to provide skill instruction leading to occupational credentials? Can the secondary school sector afford up-to-date equipment on which to train young people in occupational skills?

The fourth issue is labor market conditions. These are likely to create major planning problems for schools. While emerging new sectors require workers, those workers must be highly trained to engage in creating, designing, building, and operating the new technological tools. People who are casualties of declining occupations do not necessarily qualify for the new jobs. How do schools educate future workers? What knowledge and skills should they teach? Do they follow popular wisdom and put a microcomputer in every child's hands? Will the child who does not have a computer at home be disadvantaged? Does the school dare to argue for a balanced curriculum rather than a technology- and career-dominated one?

A fifth issue is the pressure from parent groups on ministries of education and school boards to enact school program changes. A major influence in terms of effect on money and staff allocations as well as program changes, organized parent groups have successfully lobbied for new initiatives in French immersion and special education. Similar groups are now working toward getting microcomputers into schools for student use. Often the educational value of these computer-related programs is assessed only after the systems are in place. Whether this is sound practice or not is irrelevant. The point is that parents in business, in the professions, on the shop floor, and in industry feel that for economic and employment reasons their children need to develop certain technological skills. The public system stands to lose needed support if it does not acquiesce to these demands.

These influential parent groups, the successful lobbyists, are from the higher socio-economic groups. They know how educational systems work and they are articulate in putting their views forward. They are likely to cause one of three things to happen. First, the system may respond to them by establishing desired programs only in the schools their children attend. Second, at greater cost, these same services may be offered to all children. Third, and this is most likely, the public school system may not receive the funding it needs to respond to these demands, and consequently parents will increasingly set up and support private schools. By following prescribed curriculum, the private schools will get some public funding; through their own initiatives, parents will raise money for computers, software, and other electronic gear.

We can expect to see a great infusion of microcomputers and peripherals into classrooms as a political response to demand well before any research can tell us whether computers meet expectations set for them, and regardless of major dislocations they may cause in other areas. The aspirations parents hold for their children will be the motivating force.

The sixth and final issue is that of cultural content. Foreign cultural influences are present in our schools and homes, most dominantly in media, more subtly in pedagogical material. One alarming example of the negative nature of the foreign cultural penetration is the prevalence of militaristic and violent approaches to problem-solving in computer software developed for classroom use. For many years, Canadian schools depended on foreign textbooks. Can we now avoid dependence on foreign software and databanks?

An important political reality must be brought into the picture here. Computer software development and some hardware development in Canada are decentralized. It seems that ad hoc independent groups are our most likely source of initiative and progress. It is essential that these groups receive support from institutions and provincial and federal governments at this critical creative and developmental stage. It is also imperative that they have the means to communicate with one another and exchange materials without the jurisdictional jealousies that have plagued research, development, and production in Canada. If we are to have an indigenous software industry in Canada, it must be saved from the problems that have afflicted educational textbook publishers for years - the inability of Canadian firms to compete with American publishers and the consequent use of materials with foreign content and cultural perspectives in Canadian classrooms.

The financial implications of Canadian software production are not clear. Today it is seen as a highly labor-intensive, expensive proposition. With greater integration of technology, this will not always be the case. We already have the hardware base; over the next few years, we must greatly expand our software development and dissemination capacity. To facilitate this, public financial support in the form of grants or seed money is necessary.

As we move into the next decade these issues will remain. Several factors are likely to play havoc with the notion of the traditional delivery systems for education, parent groups will push for the use of technologies in schools, labor market changes will alter the relationship of schooling to occupations, and Canadian content will be essential in software. In every instance, technology is an issue.

A final point to be made is that the new technologies will change the nature of human interaction in the classroom and elsewhere. It is a judgment call as to whether the changes will be for the better or for the worse; things will be different. Working with the computer as an individual or a member of a group will change the way we think, share ideas and tasks, and respond to problems. It may create new models of interdependence based on equality, or it may encourage individualism and autonomy at the expense of teamwork. Despite the difficulty, it is imperative that educational planners anticipate the possible social configurations and organize so that relationships conforming with our social goals may emerge.

Recommendations

In light of the issues I have raised, I propose the following recommendations:

1. That the ideal of access to quality public education for all young people be actively supported by political leaders and educators.

2. That teacher groups, school boards, and ministries of education work closely with parent groups to understand their expectations of the school system and to educate them regarding the present and potential capabilities of Canadian education systems.

3. That curriculum planners protect the ideal of a balanced curriculum for all students and seek ways of serving learners of different interests and abilities.

4. That, to provide role models for female students, women teachers be encouraged to prepare themselves for teaching computer science, mathematics, and science, and that school boards place such qualified people in these teaching positions as such posts become available.

5. That schools commit themselves to increasing the participation of female students in math, science, and technology courses.

6. That those who select computer software for classroom use include as selection criteria the nature of the values implicit in the content and learning process, avoiding those materials with violent or militaristic approaches.

7. That school boards, ministries of education, and teachers' associations establish joint technology committees at the local and provincial/territorial levels to oversee the purchase, introduction, and ongoing use of the new technologies in their systems. Each of these committees should have equal numbers of teachers on the one hand and board- or ministry-appointed people on the other. The teachers should represent the various education sectors, not only those currently using new technologies. Board and ministry appointees may include parent and industry representatives.

8. That provincial governments promote research in the ways in which learning and teaching may be enhanced by the use of the new technologies.

9. That all Canadian educational institutions encourage and support the decentralized development of software, the exchange of software, and the interaction among teachers, software developers, and educational researchers.

10. That the federal government provide financial support to groups promoting research, development and/or application of new technologies at all levels of education, both formal and informal.

THE CONTRIBUTORS

Catherine Ann Cameron is associate dean in the School of Graduate Studies and Research and professor of psychology at the University of New Brunswick. She received her Ph.D. in psychology from the University of London in 1967. Dr. Cameron has received numerous research grants and contracts from the Canada Council and the Department of Communications, and has published extensively in the areas of child development, social psychology, psycholinguistics, French immersion, and the social and psychological impacts of computer technology in education. She has presented papers on these and other topics at many Canadian and British conferences and symposia. She is currently investigating the relationship between children's cognitive styles and computers.

Louise Dubuc obtained her doctorate in educational science in 1980; her research focused on the design and validation of programmed teaching products. Dr. Dubuc has been working as department head of the Educational Technology Service of the Quebec Ministry of Education since 1979. Her principal responsibilities lie in the pedagogical applications of the computer. Dr. Dubuc has presented papers at several conferences on the pedagogical applications of the computer. Her publications in the area of educational software have been circulated in various working groups within the Ministry of Education.

Sylvia Gold is director of professional development services for the Canadian Teachers' Federation. She has taught at both the elementary and secondary level. Ms. Gold has addressed many meetings of provincial teachers' federations and national educational associations on such topics as women's issues, sex-role stereotyping in the schools, the education of native children, and microelectronic technology in the workplace. She is a member of the Canadian Association for Curriculum Studies; the Association for Supervision and Curriculum Development; the Board of Trustees of the Canada Studies Foundation; and the National Executive of the Interprovincial Association for Telematics and Telidon.

Denis Hlynka is currently associate professor of educational technology at the University of Manitoba. He has edited the Canadian Journal of Educational Communication since 1982. Dr. Hlynka has published in the field of educational technology and has presented papers at educational technology conferences in North America and abroad. His current research is in the area of aesthetic models and their application to a conceptual analysis of educational technology. Dr. Hlynka is a coauthor of a forthcoming book on videotex.

James A. Humphries is program head of the Microcomputer Management Program at Grant MacEwan Community College in Edmonton, Alberta. He holds a Ph.D. in secondary education from Arizona State University. He has served as vice-chairman on the Minister of Education's Task Force on Computers in Education. Dr. Humphries has been a consultant in computer-based education, providing assistance to teachers and administrators from the schools that comprise the Instructional Computer Network. A naval officer, Dr. Humphries developed and taught a communications course involving semaphore and Morse codes, naval procedures, and electronics.

Robert J.D. Jones is coordinator of courseware design and production at Sheridan College in Oakville, Ontario. He has been a faculty member in the departments of education at Simon Fraser University and McGill University. He holds a Master of Arts degree in educational technology from Concordia University in Montreal. His research and development interests include the design of computer-assisted learning materials and the integration of interactive video technologies and computers.

Before establishing Interactive Images Technologies Inc., **Joseph Koenig** was the executive producer of the National Film Board's English language science and education programs. Mr. Koenig has worked closely with educational psychologists in the design of communications packages for young people and adults with various learning impairments. His firm has produced a number of innovative videodisc programs for educational and informational purposes. Most recently, Mr. Koenig has developed computer-based learning programs for the Ontario Ministry of Education and Science Research Associates of Chicago.

As director of educational services for the Prince Edward Island Department of Education, **Tom Rich** is responsible for media, special education, pupil personnel, and testing and evaluation services. He received a master's degree in educational technology from Concordia University in 1975, and has worked as a lecturer at the University of Prince Edward Island, as producer/director for Calgary and Region Educational Television, and as senior producer/director at McGill University's Instructional Communications Centre. Mr. Rich is a past president of the Association for Media and Technology in Education in Canada, and was appointed to the Associate Committee on Instructional Technology, National Research Council, in 1983.

Since 1974, **Michel Umbriaco** has been a senior executive of Télé-université, a constituent unit of Université du Québec, and now serves as head of communications services. He holds degrees in educational technology from the Université de Montréal and in philosophy from the Seminary of St-Jean. Mr. Umbriaco is active in many associations and committees related to the fields of learning, teaching, and training by computer, and in the wider field of educational technology applied to distance education. He is currently vice-president of Les services médiatiques universitaires du Québec, a telematic network between universites in Quebec, vice-chairman of the Interprovincial Association for Telematics and Telidon, and vice-president and treasurer of Group Québecois de télématique et éducation.