

# Education and the Impact of Computer Technology

by Tom Rich

Once again, educators find themselves at a crossroads. Current advances in technology are having a dramatic impact on schools. The educational system faces the prospect of a radical change to a system that has remained relatively constant for more than 100 years. Before assessing the situation, it is useful to briefly review what led to the current state of affairs.

In the past, education has gone through three significant changes in technology. Formal schooling began using the oral tradition, students were told what they must know or were engaged in Socratic dialogues to "discover" knowledge.

The first revolution in education was writing. It allowed information to be precisely stored, but its potential was not universally applauded. Socrates warned that "the discovery of writing will create forgetfulness in the learners' souls because they will not use their memories . . . they will trust to the external written characters and not remember themselves."

The second revolution in education was brought about by the invention of the printing press. Before the advent of mass produced books education was only available to the fortunate few who could get access to a very limited supply of books and master teachers. With easily reproducible books, information became truly portable and accessible. It should also be remembered that at the time of the invention of the printing press, all the information known to man could be stored in a small set of books.

The third revolution in education resulted from the invention of photography. This gave us the ability to capture a representation of the real on film. With the further development of motion picture photography, education, in a sense, came full circle. Originally education concerned itself with the real, what could be touched, felt or directly manipulated. The written word distanced us from the real as it forced us to deal more with the subjective and abstract. Photography brought us closer again to the real, or what appeared to be real.

Today, we are in the midst of a fourth revolution brought about by the advent of

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what is often called the "new information technologies" — the marriage of computers with communications. Particularly significant, of course, is the impact of microcomputers on schools. It is important to note the newness of this phenomenon. The electronic computer is only 38 years old while the microcomputer has been with us for less than 15 years and readily accessible only for 7.

The new information technologies include videodiscs, videotex, interactive television, communications satellites and other powerful communications devices, but it is only the computer that has actually penetrated the classroom to any great extent. Thus, it is helpful to look at why this has happened and the implications of this technology, particularly the computer, for education.

## Impact of Computers on Schools

Although videodiscs, satellite delivery of television and other innovations have been widely experimented with, their use in education has been mainly restricted to post-secondary institutions, business and industry. This arises both from the nature of our school system and the costs of many of these new technologies. Many technological devices seem to lend themselves more to training applications where objectives, content and tasks can be precisely identified. In addition, one lesson learned from the introduction of television to education in the sixties is the importance of content. Any technological delivery device is only as good as the software (programs, if you will) it carries. The production of quality software invariably lags several years behind the production of hardware (equipment).

Why then have computers had such a dramatic impact on education? Although prices have dropped significantly in the past several years, the computer is still one of the most expensive pieces of hardware that a school can purchase and many are needed to serve a school. In addition, until quite recently there has been a serious lack of good quality educational software for computers.

Perhaps most significant, and overriding these points, is the fact that the introduction of computer technology to education has been considerably different from that of perhaps any other technology adopted by educators. This would appear to arise from four factors. First, of course, is the radical impact that computers are having on the work force. It has been variously 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 parents and employers to ensure that education prepare students to deal with the use of this new technology in the workplace.

Second is the fact that this pressure to teach about and to use computers comes as much from outside the educational system as from within. We have probably never before seen a time when parents and the media have called upon schools to adopt a particular "machine" to use in instruction. Nor have we seen quite the sort of involvement of home and school associations and others in purchasing computers for schools as we do now.

The third factor is the reaction of students to computers. A significant number of them seem tremendously excited and involved by computers. No other machine or concept has received the publicity computers have because of their seeming ability to motivate and captivate students.

Finally, those promoting computers have stressed its potential to radically change the educational system and the way we learn. Perhaps fuelled by the obvious interest of young people in computers, this has led to a common assumption that computers can and will change the structure of education. This belief is complemented by the first factor mentioned, i.e., the obvious impact computers are having on the workplace.

All of these factors, to a greater or lesser extent, revolve around the impact that the emergence of the "information society" is having upon society. As stated by Masuda (1980), the information society is based on the belief that "the production of information values and not material values will be the driving force behind the formation and development of society" (p. 29). The framework for this society is based on computer-communications technology, which determines the fundamental nature of the new order. In the industrial society the steam engine served to amplify the physical labour of man. In the information society the computer serves to amplify the mental labour of man.

Much of business and industry, and more recently governments and parents, have apparently accepted the inevitability of these predictions and are now calling for the educational system to both make use of and teach about computer technology. The schools have responded and, in a few short years, the numbers of computers in schools have climbed from a

handful to the point where at the end of the last school year more than 50% of schools in North America had at least one computer (Becker, 1983 and Rich, 1983).

## Use of Computers in Schools

The fact that educators have taken the concept of the information society to heart is seen in the types of use computers are being put to in schools. In the United States, a major study of use of computers conducted by Johns Hopkins University (Becker, 1983) revealed the following use patterns. The percentages shown are the proportion of computers used for the task listed.

Secondary schools:	
Introduction to computers	85%
Programming instruction	76%
Elementary schools:	
Introduction to computers	64%
Drill and practice	59%
Programming instruction	47%
Tutoring for special needs	41%

All other uses of the computer were below 31%. It should also be pointed out that high schools were much more likely to have a computer (85%) than elementary schools (42%). A similar survey conducted in Canada by TV Ontario (Sharon, 1984) suggested much the same pattern of use and penetration although specific figures were not provided.

The "introduction of computers" use listed along with the programming instruction reflects the response of the schools to the demand to teach students something about computers. This forms the first, and by far still most common, use of computers in schools. It is based on the assumption that a high percentage of jobs will be computer related. While, on the face of it, true this is a misleading idea. As pointed out by Menosky (1984) these jobs include everything from grocery store clerks using a bar code reader to a retailer selling video game cartridges. Although U.S. estimates have suggested 30 million jobs that are computer related, the vast majority will require no formal training about computers. Rather, it appears that the actual number of jobs requiring specific "hi-technology" training will be small.

Menosky further states that 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, waitresses and waiters, etc. In fact, there is growing evidence that the impact of computers on the workplace may result in a polarization of skills and

the de-skilling of certain types of jobs. Working on an assembly line may no longer require specialized skills, only the ability to monitor a machine and push a button. There are also concerns that increasing automation and use of technology will not create as many jobs as are displaced.

Thus, the impact of computers and other uses of high technology on the workplace may be much more complex than many realize. Certainly it is altogether too simplistic to suggest that the answer to a job in the future is to know how to operate or program a computer. The need for those skills may be significantly less than anticipated by some. The ability to program, in particular, would seem to be of use to comparatively few students in the future. This is because computers are rapidly learning to program themselves and because new generations of computers require less knowledge about computers than before. This is readily evident to anyone who has had a chance to use an Apple Lisa or Macintosh computer. For the average business computer user the emphasis is on knowing how to apply the power of a computer, not how to program it.

The second significant use of computers in schools at present is in computer assisted learning (CAL). As shown in the Johns Hopkins and TV Ontario surveys, it is typically still drill and practice activity and is most common in the elementary grades. This application of computers has been severely limited by the quality of software available. Recently the major publishers have moved into the field and substantial amounts of good software are now becoming available.

The computer is being used as an extension of a teacher in CAL activities. So far the results of this type of use have been interesting but hardly revolutionary. Research has tended to indicate that, in general, the computer is "as good as" conventional instruction (Hallworth and Brebner, 1980). Much of this may reflect the software being used and the tendency to use it in a lock-step format. Although the students can progress at their own rate they are still bound by the way the computer presents the material. Most advantages seem to come from the computer's infinite patience, its ability to repeat endlessly, and its current attractiveness to students. It is likely that boredom with using the computer for learning will set in much the same way that the flashiest video game pales after too much playing.

This is not to suggest that the computer does not offer potential for improving some facets of learning/teaching. Particularly in concert with other technological presentation devices such as video tape or disk recorders, the computer may afford excellent possibilities for providing and controlling a variety of stimuli and again bringing the learner close to the "real" world. When combined with innovative software which is responsive to students' different learning needs and styles, this offers the potential for very effective presentations. As discovered in the many experiments undertaken with large computers over the past decade, having a computer manage instruction may be much more useful than having it deliver the instruction.

The third type of application of computers in schools is their use as personal learning tools. Here the emphasis is changed, with the computer becoming a tool that the student uses to explore the world and manage activities. The computer may become a tool for creativity if used as a word processor or to generate music or graphics. Or, the computer can be used to access information stored locally in the school or at remote sites and available through communications networks. This places a very powerful resource in the hands of the student and offers an exciting potential for increasing creativity.

This type of use also suggests the possibility of viewing the computer as a problem solving tool. Papert (1980) in particular maintains that this should be the principal means of using the computer. He offers the computer and the LOGO language as a tool for creative thinking and problem solving that will dramatically increase the student's reasoning ability at an early age. Unfortunately, the supposed benefits from using approaches such as LOGO are based almost entirely on anecdotal evidences or on Papert's writing. There is still no hard evidence that problem solving and thinking taught at the computer translates to other tasks. However, if this does happen, then the computer would contain the capacity to radically change the way we teach.

Thus, we find there are three main uses of computers in schools: teaching about computers, the instructional use of computers and the use of the computer as a personal learning tool. The first arises out of changes in the workplace, the second out of a desire to make teaching more efficient and the third out of a desire to pro-

vide the student with a potent personal tool for learning and problem solving. In addition, of course, there are the management and administrative uses that the computer is increasingly performing in schools.

Whatever uses of the computer we adopt it is important to ensure that our approach to using it is a rational one and based on sound educational practice, not fads. This requires a way of determining if a suggested use of the computer is appropriate. The following are generalized guidelines that should be followed in planning programs using the computer.

The use of a computer in education is appropriate if:

1. It offers a unique educational advantage;
2. Its use is financially possible;
3. Teachers who are interested and trained are available;
4. Its role in the program is planned and well defined;
5. Relevant software is available and of good quality.

#### Policy Issues

The application of computers to education raises a number of important issues. Some come from the nature of the changes in society attributable to the 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 are neither simple nor readily apparent. It is only after we have more fully explored the uses of computers and observed their effect on society that the answers will become clear.

**Work and school:** There is no denying the pressing need to train and retrain workers and managers for the variety of new skills required in the information society. However, it must be remembered that while the demand for highly trained individuals will rise, the new technologies may also cause structural unemployment, job losses, and create more low skilled jobs (Opportunities... 1984 and Learning... 1984). As suggested by Larkin Kerwin, president of the National Research Council (Matas, 1983), it may be more important for schools to turn out graduates adaptable to change rather than ones with overly specialized skills. As a result, the need for retraining and lifelong access to education and training opportunities will assume increasing importance.

**Curriculum changes:** The study of computers is now becoming common-

place. However, this should not lead us to adopt an unnecessarily narrow approach to computer use. Programming, for instance, is not a skill likely to be needed by most students in the future (Matas, 1983). More important is teaching students how to apply the power of a computer to solve problems and about the potential social effects of information technology. The impact of computer studies on other subjects should also be noted. If computer study is mandatory, what is being left out of the curriculum to accommodate it? The importance of lifelong learning and the need for schools to turn out graduates adaptable to change suggests it may be necessary to rethink the purpose of vocational education and make sure that it opens possibilities and does not unnecessarily narrow the options of the student.

**Instructional uses:** The use of any technology must be judged to ensure its appropriateness. The same critical evaluation that is applied to other educational materials is needed to guarantee that computer software is suitable, free of bias and of high quality. By the same token, the use of the computer should encourage student growth and individuality and not simply be based on rigid performance objectives (Smith, 1983). Care must also be taken to ensure that skills being learned at the computer are or can be generalized to other areas.

**Equality of access:** Strong evidence is already available that sex biases in the use of computers arise early (Kolata, 1984 and Fisher, 1984). In many instances this seems to result from an unconscious reinforcement of male uses of the computer and from software that emphasizes games and rewards of a nature more appealing to male students. There is also a growing concern that children from economically disadvantaged families may not have access to computers, either in the home or the school. It is important to make certain that they, as well as female students, are given equal opportunities to learn to use computers and other technological devices. The use of computers in education should not result in an elite whether it be because of the cost of the technology or the type of student that we encourage to use it.

**Teacher training:** While our schools are being asked to train students to deal with the new technologies, the teachers, by and large, were trained before many of the technologies even existed. Probably the most critical factor in the use of a technology in education is teachers train-

ed 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. It is important to remember that changes based on science or technology originate in one subculture and, to be accepted, must be made intelligible and given values in terms of another subculture (Wolcott, 1981). We see the effects of this in the school where some students may know more about the computer than their teachers. This presents a particular problem for mounting good staff development programs. Other factors to be considered include fear of technology, resistance to change, anxiety over possible job loss and the increasing average age of teachers.

**Costs of technology:** The costs of introducing new technology to the classroom should not be underestimated. Most recommendations place a desirable goal of computer time available to students at one half hour per day. To do so at present costs would require at least 2% of a school district's total educational budget or about \$50 per student per year (Moursund, 1984). This may not seem like very much until one considers that the expenditures on all instructional supplies used in education — books, films, etc. — amount to only 2.5% of the total budget (Education Statistics, 1982). There is already evidence that expenditures on computers and computer software are diverting funds from traditional materials. This would not be so worrying if these were one time expenditures; however, the rapid developments in computer technology and the need for new computer software would suggest they are not.

**Social impacts:** Finally, the social impacts of the new information technology should not be overlooked. They are already being felt in the workplace. For instance, "In Short Supply", the report of the Economic Council of Canada (1982), suggested that the use of computer technology could result in an unemployment rate of up to 35% for female clerical workers by 1990. Some of this could be offset by the demand for technical and professional workers but few of the displaced workers have access to the training necessary to fill the positions. It is readily apparent that changing skill requirements will place more importance on lifelong learning opportunities. Other special issues to be addressed include privacy, the potential for regimentation,

and the effect of increased leisure time due to reduced hours of work (Masuda, 1980).

#### Conclusions:

The central questions facing us are how the educational system will make use of the new information technologies and what is their best use. Information itself is now a basic resource that supplements the natural resources of matter and energy. We are in the midst of a tremendous experiment based on exploring new ways of storing, sharing and using information through computers, information networking, satellites and other communications devices. There is no doubt that the rapidly expanding new communications technologies have helped bring about an information revolution worldwide. What is important, however, is that these new technologies not be viewed in isolation from other resources already at our disposal in schools. There is a danger in an over-reliance on any one medium. There is simply too much information in too much variety to select only one source of transfer.

It is also important that we not forget the importance of real, direct experience. Both research and experience have proven that learning is enhanced when the learner is directly involved with the actual object of consideration. The computer is not a substitute for physical manipulation of objects. Nor can it accommodate the diverse learning styles of each individual.

The classroom and the school should be resource centres, not just computer centres. In order to provide for different learning styles and interests, our schools must continue to provide a full range of

resources, including books, periodicals, media materials such as filmstrips and television and, where appropriate, computers. We must enhance learning by providing opportunities for student expression through plays and arts, motivate and reinforce through field trips and bring the outside into the classroom. In short, resources, both technological and non-technological, both human and physical, should permeate education.

The computer undoubtedly has a role to play but it cannot do the job alone. We must find the appropriate uses for the computer and help prepare our students not just for a job but for the prospect of lifelong learning. Computers in the school may be used to change the way we learn and they may become personal learning tools for students, but it is still too early to tell for certain. The challenge for us is to learn whether or not the marriage between the new technologies and the schools is one which will endure and make a better system. Indications are that it will, but that many of the details still remain to be worked out.

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