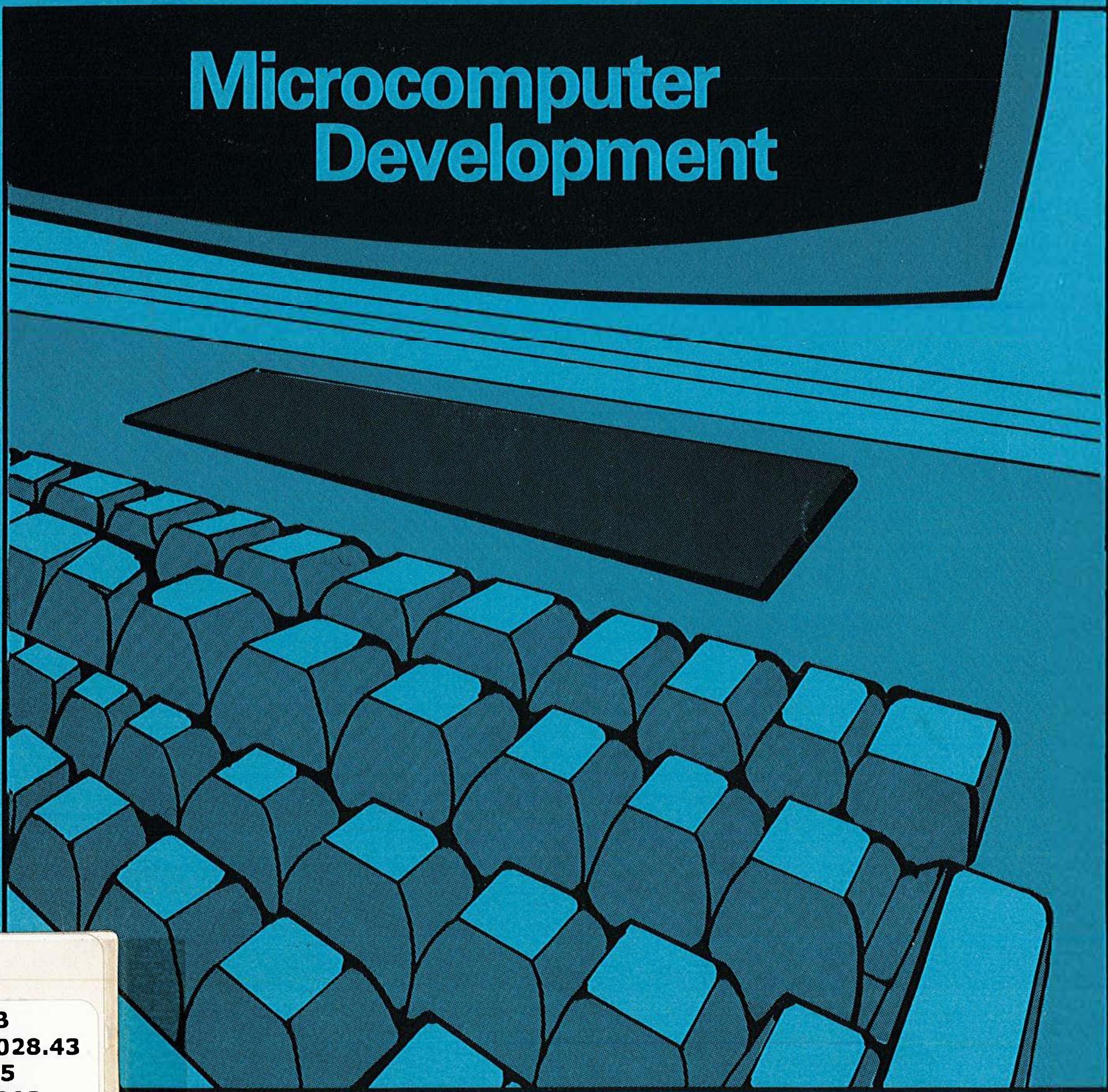
MATH Monograph No. 8

Editor: Ron Cammaert

September 1982

Microcomputer Development



A Publication of the Mathematics Council of The Alberta Teachers' Association

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Microcomputer Development

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Contents

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MATHEMATICS COUNCIL, ATA
Executive, 1981-82

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Editor's Comments

Since 1977, with the introduction of commercially available microcomputers, educators have been anticipating the availability of computers for widespread classroom utilization. Articles with titles such as "Prepare! Prepare! The Micros Are Coming!" "You and Your Home Computer," and "The School Should Lead Computer Technology" suggest that we should be doing some major things right now. Another article tells us "Computer Technology Still a Toy," and suggests that educators not rush into technology that is just beginning to grow.

Exactly what should be the role of the computer in the classroom? How should we go about developing resources? What resources are needed? What is now being done in Alberta and elsewhere in the field of microcomputers?

The purpose of this monograph is to give some information to the mathematics teachers of Alberta regarding these questions. An attempt has been made to be as current as possible; however, the development of hardware, software, and support materials seems to be occurring at an ever-increasing rate.

-Ron Cammaert

Part I

Impact of the Microcomputer

Computers and Education: Opportunities for the 1980s

by
Dale Bent

Director of Computing Services
University of Alberta

This article is abstracted from a presentation to the Western Computer Show and Conference, October 23, 1980, and articles which appeared in Computer Data, *Spring 1981.*

Public education is one of the most expensive and pervasive activities in our society. If we identify "education" with "learning" then education can be seen to be an essential part of the way we live.

Computers and their associated technology also perform an important role in modern society. During the 1980s, computers and computer communications will become even more pervasive.

It is inevitable that these two domains will interact and merge. It is now technically and economically feasible to apply computers to the processes that we know as "education."

The purpose of this paper is to outline some of the factors in computing and in education which will determine the nature of their interaction, to identify the opportunities and issues raised by the interaction, and to pose challenges for our computing professionals and educators.

The Long-Term: What Might Computers Do For Education?

The Printed Word

Much of the activity in education has to do with the written word and its associated skills, reading and writing. If we think back several centuries, one of the important reasons that scholars gathered to learn was to share the use of books. It was Bertrand Russell who said, "the only reason the lecture system is in use in British universities is that they have not yet discovered the invention of printing." On a more sarcastic note, someone has observed that the last big technological breakthrough in education was the invention of the megaphone.

Cheap, readily available, printed material makes possible mass public education as we know it today. Also, it is already clear that the computer is the greatest single innovation in the production of text since that of the printing press. Computers are being used to assist all phases of editing, printing, and publishing, using the gamut of technology from word processors through to phototypesetters. Our authors and publishers are struggling to adapt.

Yet the text-processing revolution continues far beyond this point. The linking of computers to the national telecommunications systems means that some of the fundamental reasons for production of printed pages are beginning to be eroded.

Of course, it will be a long time before most of us dispense with books entirely and rely upon imagery reproduced on the surface of a cathode ray tube. It will be some time before the storage and retrieval of information from computer systems can rival the efficiency of our modern publishing industry. But it is already clear that in the long term, if the computer is used for the capture, editing, and publishing of text, in many cases it will be more convenient, faster, and perhaps cheaper to deliver the information by computer as well.

To the extent that computers affect the production and dissemination of books, they will affect the educational process as well.

Mathematics and Arithmetic

Mathematical skills are considered to be an important part of education at all levels. In elementary education the emphasis is upon computational skills, that is, arithmetic. In higher education we move on to mathematics and mathematical logic. The purpose of this is to enable the student to acquire skills deemed important in our modern society - to understand the processes by which business, engineering, accounting, scientific, and personal financing decisions are made.

Almost all numerical processes of any significance are now performed by computers. Business accounting systems are based upon computers. Engineering and construction are planned and carried out with computer assistance. It is computers that do the arithmetic, even if only through the means of a hand-held calculator. So the chosen instruments for carrying out mathematical and arithmetic processes have changed and will change further. In the long term, it seems essential that students learn to use these instruments.

For a long time, the perceived relevance of mathematics, as it has been taught in the classroom, has been a problem in the motivation of the students. With the computer it is possible to instruct in both applications of interest and the necessary skills at the same time. It seems certain in the long term that this is the way it will be done.

Logic and Reasoning

A frequently stated goal of education at all levels is to "improve people's ability to think." Thinking includes, in part, the ability to reason, recognize logical processes, make decisions, and so forth. Increasingly, decision-making processes are being carried out with computer assistance.

Computers also seem ideally adapted to the teaching of logical reasoning. This extends from instruction in elementary logic through to complex decision making based on simulated environments. For the latter, the computer may provide the only economically practical method of instruction.

Continuing Education

One hears much about the increasing need for continuing education. The fundamental idea of education taking place at a time and place convenient for the learner seems inevitable when we consider the needs of modern industrial society. Continuing education occurs after the student has entered the "environment." That is, he is in a job situation and at a location remote from schools. But he needs access to the facilities that our institutions of education provide.

There are two possibilities: transport the student to the educational facilities, or make the educational facilities accessible to the student in his job situation. The latter will be an increasingly preferred choice.

The most effective learning takes place when the student has a problem that he is motivated to solve and needs instruction for that purpose. This will occur in life situations, on the job or off the job, in the student's place of work, or at home. Telecommunications coupled to computer-based educational resources has made education at a distance more feasible. If instruction is delivered or assisted by computer in the classroom, it can be equally well-delivered at a distance, using the methods which are now available.

Preparation for Jobs

One school of thought maintains that the purpose of education is to prepare students for their "life work." This means preparation for the jobs or occupations they will be engaged in.

In the future, computer technology will touch upon most occupations. It has been estimated that by 1990 up to 60 percent of the working population will use computers on a regular basis when performing jobs. In the longer term, the percentage will likely by higher. If preparation for jobs is an important part of our educational objectives, we must consider teaching skills in using the computer systems as a prerequisite for effective job performance.

Summarizing the Long Term

In the long term, computers and computer communications will fundamentally alter most of the important processes we call education. Therefore, our educators must come to grips with how computers will be integrated into our educational programs.

If this is true, and considering the characteristics of our educational institutions, we can see that change will be of revolutionary proportions. The interaction will be pervasive, important, and perhaps crucial to the future shape of our society.

It is natural to ask: "What are we doing now?" "Are we planning for change?" "What are the instruments for change and how are they being managed?" and "Is the 'educational establishment' positioned for change?"

The Short Term: How Are Computers Being Used in Education Today?

When we look at what is being done with computers in education today, we can see that the revolution has barely begun. Computers are being used to some extent in higher education and a little in public education. Computer communications technology is barely being used at all. The purpose of the following section is to outline some of the ways in which computers are beginning to be applied to educational processes.

There are three main ways in which computers can be used in education. These are:

1) Teaching with computers: Computer-Managed Instruction (CMI).

2) Teaching about computers: Computer Science and Technology.

3) Teaching by computers: Computer-Assisted Instruction (CAI).

Computer-Managed Instruction (CMI)

By "teaching with computers," I mean the use of computers to aid traditional instructional processes. This is being done in a number of ways, particularly with the use of data-processing equipment in our school boards and our departments of education. Activities which fall into this category include record keeping about students, teachers, and facilities.

So far, what has been done largely amounts to automation of the traditional record-keeping which was necessary in a school or at a system-wide level, such as in municipal school board offices. The facilities have been introduced to aid the work of administration of the schools or the educational systems as a whole.

Little has yet been done to directly aid the teachers and instructors who provide the information which is recorded for administrative purposes. Test results, grades, and the results of counseling are manually prepared, summarized, and entered into data-processing systems. We can readily visualize a means whereby computers are put directly at the service of the staff who are preparing this information. They could enter the data directly into an information system, thus eliminating the need for manual reports.

When the progress recording of a student during a course is automated, this is frequently referred to as CMI. With CMI, a teacher can more readily track the progress of students during the course, and retrieve information in a timely way to assist in counseling. This can free the teacher from onerous routine chores, and enable him to spend more time on the important matters of motivating, counseling, and dealing with learning problems.

However, the introduction of CMI has potentially a more revolutionary implication. A student given direct access to CMI facilities can get direct guidance without teacher intervention. The teacher can specify the instructional logic and leave the process of routine tracking of student progress to the computer itself. With the use of a computer it becomes feasible to permit individualized instruction. With individualized instruction, each student can progress at his own pace and through an instructional sequence relevant to his needs, rather than in lock-step as is typically the case.

One of the reasons that lock-step instruction is used is the sheer complexity of keeping track of the progress of 30 or more individuals. If the task of monitoring student progress can be turned over to a computer system, with exceptional or summary reports available to the teacher on request, then the barrier to individualized instruction is removed.

Once the records of student progress are available in machine-processable form, it becomes possible to begin to manage the instructional activity in a more rigorous and scientific way.

CMI does not require any alteration in the content of current educational curricula. It seems readily achievable with off-the-shelf technology. The cost might include one terminal per classroom, telecommunication lines, and a central computer either at the school or in the central school board office.

The amount of CMI being carried on today is almost nonexistent. Little direct use of the computer is being made by either students or instructors. Yet this is where the short-term manpower savings are potentially the greatest!

Computer Science and Technology

Computer science has been taught at different levels in our educational system for several years. In spite of the dedicated efforts of many of our educators, there are still a number of deficiencies in the way in which this is being done.

At the public school level, computer science is not integrated into the curriculum but is taught as an option. The prescribed curriculum is also obsolescent and deals with topics such as computer-card punching and COBOL programming. Very little is taught about computer electronics, and virtually nothing is taught about computers from a system-wide point of view. This systems point of view may be even more important than learning about the electronics and technology of computers.

Microcomputers are being introduced, often on a voluntary basis, and sometimes using the personal money of teachers. Very little is being done to coordinate this work from a system-wide point of view. There is a great deal of duplication of effort and no systematic way of sharing experiences. We still lack a plan for introducing computers into mathematics and other subjects.

In our universities and technical schools, computer science educators are struggling to keep up with enrollments and to meet the needs of the community and their students. They have been hampered by institutional rigidities which are different at each institution. In universities, the increases in enrollment have not been matched by corresponding increases in staff because it is very difficult to quickly redeploy financial resources in a university, and there are almost no new monies available for staff appointments. There have been similar problems in the institutes of technology.

In many cases, our institutions of higher education are not providing what the business community would like to see. What is being taught in our courses is often several years behind the time. There is an overemphasis on the "science" of computers and programming, and insufficient emphasis on systems methodology, the management of information technology, and the use of computers as problem-solving aids.

There is no doubt that many students are being frustrated by the lack of opportunity in our institutions of education. Brighter students frequently pay for computer time and equipment out of their own pocket in order to prepare themselves for what they realistically believe the job market requires.

Computer-Assisted Instruction (CAI)

As a result of the pioneering work of some educators over the past 10-15 years, it has now been conclusively demonstrated that instruction by computer can be effective in almost any subject area. Systematic research has demonstrated that it is possible to enhance the speed of learning, retention, and skill level at reasonable cost using a computer as the teaching medium. More important, the computer can be programmed to adjust to the student's own pace and special learning requirements through pretesting and control of the instructional logic which adjusts to responses that the student makes to the computer.

When properly applied, most students find instruction by computer to be interesting and motivating. Usually, the instruction in a course will not be completely replaced by computer but will be supplemented by computer for appropriate material.

For example, in a course in economics, the computer can be programmed to simulate the results of economic decisions in a model economy. This may be very difficult to teach by other methods. The range of methods which have been shown to be effective include drill and practice, dialogue, simulation, tutorial, and direct computation.

The cost of CAI has been reduced sharply by advances in computer technology and will continue to fall. It is claimed that the cost of instruction is as low as 25 cents per student contact-hour in some cases. Personal computers such as the APPLE, TRS-80, and PET can be obtained in the $1,000-$2,000 range, and courseware is becoming available for these machines.

In public education, microcomputers are being used for CAI in some schools but teachers are struggling with inadequate courseware, and there is little system-wide planning as yet for the use of these facilities. Experience has shown that the development of effective courseware requires a long-term commitment and perhaps 100-150 hours per student contact-hour of instruction. Only the most dedicated instructors are prepared to undertake the development of courseware in addition to their regular teaching load. There is often scepticism about the validity of using computers for instruction, and hence most institutions do not have a policy to reduce the workload of an instructor who has dedicated himself to the development of courseware.

Careful attention must be paid to the instructional design and lesson content as well as the programming in order to produce effective lessons. Few educators have skills in all of these areas, and there is a high risk of failure when the development of courseware is undertaken on an individual basis. Courseware would be best developed on a system-wide basis but in most provinces there is neither a system-wide plan for doing this nor a general framework within which the work could be undertaken.

The 1980s: A Time of Opportunity

The 1980s will be a time of great opportunity for the application of computers to the problems of education. There will be opportunities for government, computer suppliers, our institutions of public and higher education, and our professional associations.

The opportunities have been created by the amazing and unprecedented decrease in cost for computing power. This trend has continued through the 1960s and 1970s, and most informed opinions indicate that it will continue through the 1980s. The cost of computer logic circuits will be cut in half approximately every three years, leading to a large increase in cost effectiveness by the end of the decade. Costs for other kinds of peripherals will also fall but not at a similar rate. Costs for such devices may be three or four times less ten years from now than they are today.

Although cost effectiveness for educational applications is a complex function of the cost of computer equipment, software, and personnel, it is probable that during the 1980s we will cross over the point at which it will be less expensive to perform functions which are capable of being performed by computer with the use of a computer. We have already passed this point for many important applications in computer-managed instruction and education in computing science.

The problems are many, but so are the opportunities. To properly exploit the opportunities will require the cooperation of many different agencies in the private and public sectors, and also of our professional groups.

Summary and Conclusions

My biases will have become clear at this point. Looking to the long-term future, I am convinced of the following:

1) Computers and computer communications will become the indespensable tool of public and private enterprise in the future.

2) An "educated man" will need to understand at least the basics of computers in order to function effectively.

3) Appropriate educational policies for computers, information technology, and computer communications will become a necessity in a modern, industrialized nation.

4) Computing technology will affect every aspect of the educational processes.

5) Educational institutions which do not take up the challenge and exploit the opportunities will be replaced by other agencies.

6) A fully effective program for the educational use of computers requires the cooperation of our educational institutions, of industry, of governments, and of professional associations.

The choice is clear. We can sit back and await developments and thus play a second-class role, exploiting the advances which will be made in other jurisdictions, countries, or provinces, or we can dedicate ourselves to the objective of creating the finest program in the world for computer-based education. We certainly have the resources and the educated people. Perhaps we have the willingness to accomplish this objective. As educators and computer professionals, what could be more worthy of our efforts?

The Impact of Technology On Public Education

by

Desmond E. Berghofer

Alberta Advanced Education and Manpower

This address was given to the ASCE convention in Edmonton in November 1980.

Public education is in a period of great stress throughout the industrialized world. It has reached that stage in its evolution as an institution when its technology has matured, and it is facing a future of diminishing returns.

Since education is embedded in society, policy makers should look to the social, economic, and cultural environments for insight on appropriate action. The direction for change will be found more by intuition than by rational analysis. It is a mistake to look too deeply at details. These are so numerous that they can cloud the issues. A broad outline of conditions and a general sense of which direction to steer are what count. If we use this perspective to view the context of education, some amazing shifts become evident.

The most significant change is in the creation and manipulation of information. The industrialized world is literally awash with it. From the detailed specifications of work-related information to the blow-by-blow description of current events from all over the world, people in every part of their lives are assailed by facts, opinions, rumors, and lies. To survive, people must know how to process that information in ways that lead to personal satisfaction rather than to psychological disorientation. Students growing up and learning in this turbulent ocean of information require ways and means of learning which are compatible with the environment.

A single phenomenon is responsible for the exponential increase in information: electronic communication, including unprecedented power of computation. Information is now electronically transmitted, manipulated, and stored in huge quantities and at incredible speed, all of this being in addition to a voluminous supply of print materials. This has been referred to by some as the "information revolution," an event equal in significance to the industrial revolution. What brought it about was the invention and steady refinement and improvement of some truly remarkable electronic communication devices: telephone, radio, and television. Added to that now is the computer, which not only transmits and presents information but manipulates it in accordance with instructions given by the user. So subtle has this power of computation now become that man and machine are virtually interacting at a cognitive level. The development of the microprocessor is making this computing power more readily accessible to the individual, so that we are now moving rapidly not only into a world of information, but also into a world in which the individual, even with minimal computer literacy, will have steadily increasing access to more and more personalized information services. This will constitute a fundamental shift from a society of consumers who were accustomed to receiving the bulk of their information *en masse*, in broadcast mode, to a more individualized society in which people will look for and create more personalized information exchanges.

Educational Implications

The above development has far-reaching implications for public education, particularly at secondary and post-secondary levels. The most significant point to grasp is that enormous pressure is building up to shift the focus of the educational process from the teacher to the student. A learner-centred system is fast becoming a reality and a necessity on several counts:

1) Greater individual access to data bases and sources of information.
2) The development of accessible, interactive instructional devices.
3) A shortage of skilled human resources enabling the individual to command more attention in order for his services to be acquired and retained and for his productivity to be increased.
4) Rapid obsolescence of technology thereby requiring highly flexible on-site upgrading of individuals in cost-effective formats.

The creaking machinery of an educational system based on an industrial model of a mass production of graduates by a process of time-specific "learning" events will satisfy no one. The students will not be satisfied because they will intuitively know that they are wasting time in school. The teachers and professors will not be satisfied because they will get little pleasure out of working with bored and reluctant students. The employers will not be satisfied because they will not get competent recruits out of the educational institutions. The government will not be satisfied because it will wonder why it is spending so much money for so little economic and social return. Finally, the public will not be satisfied because it will imperfectly sense all of the above frustrations and complain that something should be done about them.

Even more potentially serious than all of the above, however, is the danger that there will be an almost total preoccupation in society with "maintenance" learning: individuals and industries trying to extract from the hodge-podge of learning environments, skills, and manpower to keep them viable as economic units; and educational institutions so preoccupied with their own economic survival that they cannot get any clear-sighted policy together that addresses the larger educational issue of improvement in the human condition world-wide. This is the issue of "innovative" learning being overwhelmed by "maintenance" learning. To neglect this issue in a world as dangerous and volatile as today's world would be most unwise.

Policy Issues

In the face of such pressures, educational policy must be concerned with two paramount issues: changing the technological base of education in a direction consistent with the changing technological base in the larger society; and restructuring responsibilities for maintenance learning and innovative learning.

It is not the intent here to elaborate in detail on specific policy direction with respect to these two issues, but rather to indicate a general direction which can guide strategy.

Concerning the former issue, government should take the initiative in providing incentives and controls for institutions to shift instructional content and delivery to a more learner-centred approach, capitalizing on interactive communication technologies. This entails promoting greater cooperation among institutions, establishing direction for the acquisition of hardware, encouraging greater standardization in the production and acquisition of software, and generally showing leadership and demanding change.

Concerning the latter issue, government should recognize the limitations of institutional-based training for vocational purposes at all levels of skill requirements. The new technologies are making industry-based training and part-time study a much more viable approach for maintenance learning. In the area of innovative learning the rich resources of the existing educational institutions need to be integrated with the capabilities of other social institutions, particularly the media, to awaken the need for greater public understanding of human problems and the public's participation in finding the solutions to these problems.

In making these comments to senior officials in the Department of Advanced Education and Manpower, what I was essentially arguing was a need for government to provide policy direction and flesh it out with consistent strategies. By doing so, government would be taking positive action to assist public education to develop a new, more viable relationship with the society it serves.

We are not playing around here with electronic toys. We are going to be facing some hard decisions on such highly volatile issues as: control and allocation of resources; changing roles for teachers and the emergence of new roles; retraining of personnel; revamping of teacher-preparation programs; shift of the control of education from the teacher to the learner; reformulation of curriculum materials with tremendous pressure to shift from a print basis to an electronic basis; and rethinking of concepts such as compulsory education and life-long learning.

The significant issue is not going to be the hardware. By the mid 1980s our culture will be flooded with it. The issue will be what software to put on the hardware and how to arrange delivery. We have not figured out these issues for television yet, and it has been around for more than 20 years. Now we are talking about a new technology and, indeed, the marriage of this new technology with the technology of television for the purpose of stimulating learning in human beings.

This is a remarkable challenge. Let us not underestimate the enormity of it and let us not dissipate our energies by engaging in recriminations which emerge because, of necessity, any one of us views these matters from a limited perspective. Let us aim at widening those perspectives and undertaking to work together at what needs to be done.

Implications of Computerized Education

by
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Alberta Society for Computers in Education

As an educational planner, I have ample opportunity (indeed I am forced) to analyze trends in society and ascertain what implications, if any, they will have on the educational system. I am convinced that the microprocessor revolution will have more impact on the way we live and work than any development since the industrial revolution. The educational system, designed to prepare our youth for useful and productive roles in society, will be significantly affected.

Another important lesson I have learned in my short tenure as a planner is that there are often unforeseen, but major, unpredictable ramifications in these technological developments. Therefore, rather than talking about the visible topics of hardware, software, and courseware, I would like to reflect on some of the potential issues which may arise in education as a result of the proliferation of the computer.

Basic Skills

I find it extremely ironic that although a computer can retrieve and process data in millionths of a second, the rate the information is transmitted to an individual is dependent on his reading speed. The man-computer interface is predominately the printed word. Therefore, no matter how efficient the processors become, the key factor in utilization becomes how well a person can read. Thus, I expect an increased demand will be made on our educational systems to teach individuals how to read quickly and effectively. Basic reading skills will become increasingly important.

Data banks always have limited storage capacity. Therefore, the information stored in them must be written in a concise and precise manner. I believe that the technological revolution will have an impact on the written language. Short, clear, and concise writing will be encouraged to ensure maximum storage capability and easy reader use. Even words and language structure may be altered to meet the needs of economy and effeciency. Eventually this language will find its way into everyday speech. The educational system will be required to teach these basic writing skills.

Like writing, math will be taught in a different manner. With computers and calculators, computational skills become less important. However, with the greater access of mathematical tools, greater emphasis will be needed on application and interpretation. In fact, learning how to use math in decision making will become an integral part of the basic educational system.

One of the more interesting side benefits I have observed in teaching computer courses is that working with computers improves the logical reasoning and analytical skills of students. It will become necessary for schools to teach students rigorous, disciplined reasoning and problem-solving skills. I suspect that the emphasis will swing from the "creative" to the "disciplined" in order to enable students to cope with the new technology.

I cannot help wondering what effect the technology will have on interpersonal skills. Many of the activities done today involving people will soon be done by machines. Banking is one example in which the "Green Machine" is replacing the smiling teller. (In fact, a restaurant in Toronto has become totally computerized.) The machines are efficient, eternally patient, and do not mind being insulted. I am not sure whether the overall impact will be negative or positive, but it will probably be significant.

The Educator

I will not dwell on the role of the computer in the classroom. This has been sufficiently covered elsewhere. I will examine other implications for teachers.

First, a massive retraining and upgrading effort will be required to enable teachers to cope with and utilize the new technology. Unlike other educational fads, the computer cannot be ignored - it will not go away. The technology is so all-pervasive and encroaching that an educator ignores it at his own peril. Staff development for teachers will become more important than ever before.

The computer will have an impact on work loads. Teachers will be working differently with computers in their classrooms. This means some changes in contracts between teachers and their employers. I expect uncertainty and confusion for some time before this issue is resolved.

Related to the above issue is one of security. It is likely that many educators feel anxious and uncertain about the advent of computers. This is understandable and predictable. However, it means that unless these concerns are handled well, the result will be resistance, hostility, and other forms of dysfunctional behavior. There may also be an increase in turnover among teaching staff. Major technological change can have adverse and disruptive effects on the staff. One should expect considerable anxiety and disruption over the next few years until teachers accept and utilize the computer.

A final issue I would like to address is that of time and resources to develop course materials. Until such a period as adequate, educationally sound courseware is available, many educators will need to be encouraged to produce appropriate materials. Those of us who have been involved in this process know that it is very time consuming. Therefore, I expect that demands will be made by the educators for time, resources, and incentives to develop materials. This will cause further strains on the already limited resources of most systems.

The System

The computer revolution will cause many interesting problems and challenges for our educational system.

Difficulties will be encountered in the management and administration of the technology. Decisions will have to be made on a number of issues: where in the organization the technology fits in; who should be responsible for it; whether it should be centralized or decentralized; and other decisions. In addition, senior management will have to be educated as to the implications of computers.

Resource personnel will be required to assist educators effectively utilize the technology. A question arises as to the most appropriate qualifications of these consultants. Should they be computer specialists, content specialists with some knowledge of computers, or should they be specialists in both computers and their content area? Another concern is that there exists, and there is expected to continue to exist in the foreseeable future, a tremendous shortage of computer personnel.

With the advent of distributed processing and improved communication capabilities of all computers, the potential exists for developing centralized educational resource databanks. This would enable educators throughout the province to have access to and use of far greater materials than any individual system could afford. However, this also opens up nightmares of coordination, funding, jurisdictional disputes, capabilities, etc. The negotiations will be long and difficult and will likely delay the establishment of such resource centres.

One issue which has already raised its ugly head is a regulation known as the "seat time" rule. This requires a student in the basic system to have so many classroom hours in a course prior to being permitted to advance to the next level. A similar problem may exist in credit courses at the post-secondary level. A problem develops when a student, using a CAI package, masters the material in less time than he would by traditional methods. This is cited as an example that there probably exist inummerable provincial regulations which are incompatible with the use of technology in the educational system. Changing these regulations will take time and effort.

Summary

The computer revolution is here! It will have a major impact on the educational system. The technology will affect the teaching of certain basic skills which will be required to cope with the changes: for example, reading, writing, math, and reasoning. The revolution will affect the educator. It will probably require considerable upgrading and staff development; it will affect staff workloads; it will require development and production of materials; and it will affect the mental well-being of staff. Some of the implications for the overall system include such things as: educating management, organizational changes, appropriateness of resource personnel, and development and maintenance of resource centres and provincial regulations.

It is often the unexpected consequences that cause the most problems. Certainly the introduction of computers into the educational system is happening quickly. It is hoped that by alerting the reader to some of the potential problems, the disruptions and obstacles can be minimized, and the computer can become an integral part of our educational system.

Microcomputer Report of the Minnesota Educational Computing Consortium

by
MECC Instructional Services Division

Background

The use of microcomputers is a relatively recent phenomenon that has occurred in a variety of application areas on a nationwide basis. Interest in microcomputers is high, and it is difficult to stay abreast of an exploding knowledge-base. During 1979, the microcomputer industry has been stabilizing. The phenomenal growth of retail sales and distribution outlets that occurred in 1978 has slowed, but 1980 will see the industry begin to escalate and touch practically every dimension of society. Microcomputer manufacturing should catch up to the demand for equipment in 1979. Distribution channels and retail outlets will be handling selected equipment lines rather than whatever is available, and the public's expectations about microcomputers tend to be ahead of capahilities and the knowledge required to effectively use these technological devices.

Since education tends to pick up on technological advances after business and industry, a significant increase in the sale of microcomputers can be expected during 1979-80. This is particularly true for systems costing less than $2,000. Inexpensive systems are well suited for activity in introductory programming and small instructional simulations. The current number of microcomputers in education is estimated to be 25,000 and will swell to 100,000 by 1982. Radio Shack's "Introduction to Microcomputers" packet sent to every school district in the country, Commodore's "Three for the Price of Two" sale, and APPLE's feature magazine on "Computers in Education" are examples of events which have familiarized the educator with the potential for obtaining and using microcomputers.

Software development and related instructional support for the promotion of classroom computer activities will not keep pace with the initial movement toward microcomputer usage. In the case of many of the systems, use will be impeded because of a lack of hardware/software features. In order to meet the expanding need for assistance with microcomputer hardware and software, it is necessary for educational service agencies to broaden support in these areas. Microcomputer companies will be able to promote sales by providing materials and methods for incorporating computer technology into the classroom. Textbook publishers are just beginning to explore the potential of producing learning materials based on microcomputer technology.

The 1978 Microcomputer Report

In December 1977, the MECC board of directors established the Microcomputer Task Force for the purpose of advising the Executive Director and MECC member systems on matters related to the evaluation and utilization of microcomputers for instructional computing services. Three general recommendations resulted from the task force activity and each is summarized below:

Acquisition of Microcomputers

It was recommended that MECC release an invitation for bid for the acquisition of microcomputer systems by any non-profit, education-related organization. The statewide bid defined for manufacturers and vendors the specifications for a microcomputer to be used in the educational environment. The bid also served as a guide to educators needing assistance in acquiring a system to meet their needs. Bids were received and APPLE Computer, Inc. was the successful tender. The resulting statewide contract for purchase of microcomputers allowed MECC members and others to purchase the APPLE II microcomputer system at a cost reduced by APPLE's education grant.

Support

It was recommended that MECC provide support services to Minnesota's educational users of microcomputers. Support for the 1978-79 school year concentrated on the APPLE II system which was awarded the statewide contract. This support fell into four general categories: 1) purchase, installation, maintenance, and documentation of the system; 2) training in system operation and use of applications packages and programming languages; 3) acquisition, conversion, development, maintenance, documentation, and dissemination of applications packages; and 4) response to questions, problems, and requests for assistance.

Microcomputer Technology and Instructional Computing

It was recommended that MECC continue to analyze microcomputer hardware and software technology and continue to disseminate the resulting information to the Minnesota educational computing community. As that report was being written, new advances in microcomputer hardware and software were released which enabled educators to do more computing in ways not possible on then-existing microcomputers, and at reduced costs.

Microcomputer User Considerations

The 1979-80 school year will be one of transition for users of computers in Minnesota schools and colleges. The move will be from almost exclusive use of large mainframe systems delivering timesharing services to a combination of timeshare systems and microcomputers.

To date, the actual number of Minnesota school districts experienced in the use of microcomputers is small. Less than 10 percent of the schools have used microcomputers. This is rapidly changing. By fall, 1979, 50 percent of the school districts currently using computers, and all of the colleges, will have some microcomputers in their educational programs. Some of the specific modes of microcomputer use in schools and colleges are given in the table following. Teachers and instructors expect to use microcomputers in three different aspects of their educational programs.

First, microcomputers will be used to provide equipment for the teaching of computer programming. In general, the BASIC computer language is taught. In the past, 50 percent of the use of computers in schools and colleges was in computer programming.

The second use of microcomputers is execution of computer program applications ranging from mathematics drills to science simulations. The greatest growth in the use of computers in education is expected in the area of applications. The majority of current microcomputer purchases are being made for special education services, and various subject area departments in high schools and colleges.

Third, microcomputers are used to teach about computers in the "introduction to computer" course taught in colleges and in specific "computers and society" courses taught in secondary schools. For example, the computer is sometimes used as a part of a social studies class in which students may study the role of computers in society.

Educational Applications for Microcomputers

Art

Graphic techniques
Form
Color and medium mixing
Art production and art history in CAI

Business

Data processing
Management
Programming
Financial courses
Accounting courses
Statistics
Economic simulations
Marketing simulations

Industrial Arts

Variable dimensions
Stress analysis
Cost and time computations
Use of tools, construction techniques, wood furnishing, planning layout, and safety in CAI

Language Arts

Language structure simulations and operations
Translation problems
Individualized units on grammar, vocabulary, spelling, and sentence structure

Mathematics

Computer applications
Routine calculations
Variables in complex relationships
Conic sections
Graph functions
Number-line operations
Geometric figures
Real-life simulations with a mathematical base

Music

Computer-generated music critique
Music form, harmony, rhythm, compositional techniques, transposition, and music history in CAI

Physical Education

Defences, plays, and strategies
Team statistics
Game rules

Pre-Medical and Medical School

Biological or medical diagnostics
Data reduction

Reading

Self-paced instruction
Reader progress management
Diagnosis and prescription
Individualized reading
Multi-modal

Resource Centre

Information retrieval
Media equipment scheduling and checkout
Cataloging
Records for acquisitions, supplies, reserve books, budgets

School Management

Attendance records
Budget control
Computation of grades
Data processing
Inventory management
Progress of programs mandated by PL 94-142
Scheduling
School calendar
Test scoring
Trend analysis

Science

Chemistry
Chemistry and physics simulations
Laboratory equipment testing
Theory examination
Computer technology
Electrical engineering theory

Social Science

Human/environmental interactions
History drill
Government interactions

Special Education

Individualization with progress data
Self-pace instruction with branching

*This table is based on information compiled by Bell & Howell Audio/Visual Division (distributors of microcomputers).

Appeal of Microcomputers

Educators in Minnesota are taking great interest in microcomputers. They see the microcomputer solving some problems posed by large-scale computers: the need for and cost of telecommunications, timeshare hardware costs, and lack of local control of computing resources.

The terminal to timeshare computer connection requires the use of telephones. Telephones are not located in every classroom and thus the use of computers in instruction has been in restricted and often limited locations. The cost of the telephone communications can be high. In addition, there is the use of the telephone with shared access to the computer, which can mean the frustration of busy signals.

The low cost of microcomputers means that computers can now be introduced into curriculum areas where they were once too expensive. Particularly notable is the number of microcomputers available now in the elementary schools. Also, microcomputers are being used to add computer resources to programming classes where a shared terminal for 30 students has long been a problem. Colleges are finding that microcomputers provide an inexpensive and practical way to add computer resources to their increasingly popular introductory courses. Voice input/output capabilities generate new uses for computers in schools and colleges. Graphics and the faster rate of information-display interest both experienced and inexperienced computer users.

Many schools prefer to do and to control their own computing. Paying a service fee and sharing a resource with other institutions is not as popular as paying a one-time purchase price and having control over the equipment. When a microcomputer fails, the failure is easier for the user to understand and accept than the "downs" on remote systems. However, if the microcomputer requires repair, the owner pays the cost and waits while the machine is at the repair shop.

Hardware

The specific hardware requirements for microcomputers used by Minnesota schools vary according to the application. In general, the need for a hard-copy printer is much less in an elementary school than in a high school programming class. Similarly, the elementary school may well need a larger system (more RAM storage) than the high school programming class since the elementary application programs are more complicated than those of the high school.

Colleges have a greater need to interface peripheral equipment with a microcomputer. In addition to adding hard-copy capability, there is also a need to interface with other computers and with laboratory devices, and to add other types of experimental modules.

Since distributing and sharing microcomputer software can be easily handled through a centralized computer system, it is important that microcomputers be able to communicate through standard modems to a host machine. The most practical interface is an RS-232. This interface is compatible with variable baud rates. New types of small modems allow for interesting and practical inter-microcomputer communication and microcomputer-timeshare connections.

User needs for microcomputer features also vary with experience. Initially, it was thought very satisfactory to have a BASIC-only microcomputer. As microcomputer technology advances it is becoming evident that other language capabilities are going to become essential in the educational computing environment. Users now expect their microcomputer to have some degree of graphic capability. Many expect the graphics to have a high resolution and also to be in color.

Perhaps the greatest concern for microcomputer hardware is that it be dependable. If there is a breakdown, service must be readily available so that the unit can be restored in a short period of time. It is assumed that as the number of microcomputers in schools and homes increases, the number of service centres will also increase. Currently, schools are limited to the few retail dealers who also provide maintenance/repair service. Maintenance/repair service must increase to insure microcomputer reliability.

Software

The need for software falls into two categories: system software and applications software. The programming instructor finds a need for a good BASIC language. Currently, there is little interest in other higher level languages or in machine language at the secondary level. Colleges, on the other hand, find alternate languages such as PASCAL to be of value.

Educators are greatly concerned about the availability of applications software. Few are interested in purchasing a microcomputer without the assurance that software will be available. To date, there is very little commercial applications software which has any educational value.

The promise of the microcomputer is that many individuals and groups will be developing applications software. As this activity emerges the concern will be dissemination. Much has been said about the ease of disseminating via cassette or tape. True, it is a simple process, but until mechanisms for carrying out the process are in place, not much dissemination will occur. These mechanisms, whether commercial or cooperative, will have some real costs. Software will not be "free."

In addition to the obvious dissemination mechanisms there is transfer from one computer to another called off-loading. In Minnesota, off-loading is electronically moving computer programs and data files between a timeshare system and a microcomputer. Off-loading works both directions, downloading being the transfer from the large statewide timeshare system to the microcomputer and uploading being the transfer from the microcomputer to the timeshare system. The off-loading capabilities provide an effective means for disseminating software statewide.

Downloading through a timeshare network offers some unique advantages to users as they build up program libraries on their microcomputer diskettes. Users of downloading have the advantage of being able to group programs on diskettes in an arrangement which best suits their needs. For example, programs relating to geography can be on one diskette, science programs can be on another diskette, and so on. This program transfer is done by the user without anything more than calling to obtain the most current copy of the rapidly changing software.

The downloading process offers tremendous dissemination potential but it can be time consuming. Even at 30 characters per second, programs which use special data files and chain to other programs may take several hours. Downloading binary special situations standardized program sets on discs will be available for distribution to users. (Microcomputer software availability is the focus of the third section of this article.)

Support

The new owner of a microcomputer in education is not like the average hobbyist, who enjoys tinkering with a system. Simply setting up a microcomputer, no matter how explicit the instructions, is a task some teachers are unwilling to perform. It is essential to have some support available to new users. This service has generally been more than a local vendor can supply. MECC Instructional Coordinators have assisted Minnesota users by delivering and installing equipment, and providing initial training at the user's site. Also, MECC staff have written a "New User's Guide for the APPLE II" to assist the new user. This publication is available through the MECC Publications Department.

Workshops are necessary to get users off to a good start. The workshop sessions cover many of the "tricks" of using a microcomputer system, the BASIC language, and special microcomputer programming features. As owners begin using microcomputers they find a need for answers to specific technical questions which cannot always be found in the manuals. These questions often require additional consultant help. MECC's User Service staff, including a user consultant who can be called on a toll-free telephone line, provides this service.

As needs change, the user often wishes to add peripherals to the system. The first such peripheral is often a hard-copy terminal. Sometimes the user wants advice on more exotic units. The MECC user has a need for competent advice on peripheral alternatives. At MECC such services are provided by the User Services staff.

Microcomputer Software Availability

The past decade of instructional computing experiences has convinced educators that computing hardware is only part of what is needed to make effective classroom use of the technology. Good quality software, for applications as well as systems, is vital. Applications software usually requires some complementary written materials. These materials may be in the form of student worksheets, teacher guides, and resource booklets. The combination of these learning support materials and the applications programs (software) is referred to as instructional computing courseware.

High quality, educationally sound applications for microcomputers comprise a very real need in education. This section addresses the various sources for microcomputer software, summarizes what is happening in the area of software, and describes various methods of distribution. Types of current applications and near-future innovations are also discussed.

Sources for Applications

There are at least four major sources of instructional computing courseware development:

1) Commercial publishing or software houses.

   There are indications that publishers' interest in microcomputer courseware is growing. A few companies, established in related businesses, are now in the microcomputer software business. In addition to small software companies established primarily for software development, some small educational publishers are preparing to release initial applications products. If these initial efforts are successful, then the larger education publishers may move into this field.

2) Hardware manufacturers.

   Some major microcomputer vendors are expanding their software library offerings. This expansion, through some development but mostly through author royalties offered to individuals and organizations, should bolster the quantity and quality of available courseware.

3) Educational cooperatives.

MECC and other educational cooperatives are a prime source of instructional computing applications. At the present time, most courseware from educational cooperatives deals with specific topics, and comprehensive units of study have not yet evolved. Many of these cooperatives have a reputation as providers of sound instructional computing software. The software developed at these locations may eventually be made available to microcomputer users, especially within the educational community, on a low cost or exchange basis.

4) Individual school districts.

There are many individuals and teams currently developing software in local districts. However, locally developed software is often written to meet the specific needs of a school and may have less applicability in other settings. It is often difficult to locate software developed by individual districts. A teacher may never hear about an excellent set of applications produced by a neighboring school.

Applications Currently Available From MECC

1) Converted Applications

At present, MECC staff has made available to MECC users over 100 microcomputer applications programs. Many of these programs have related courseware materials available; that is, the software is complemented by appropriate written materials for the teacher and student. These programs are primarily conversions from the MECC Timeshare system to the APPLE II microcomputer. The conversion process from a timeshare terminal orientation to the screen oriented APPLE is generally a two-step process. After downloading the program into the microcomputer, the program is converted for correct syntax and good screen presentation. The second step is to take advantage of the animation, color, graphics, and sound capabilities of the microcomputer. These special feature capabilities are added to a program only if the effectiveness of the program is enhanced by such an addition.

2) Microcomputer Utilities

Utilities to aid in activities such as downloading programs from the timeshare system, generating high resolution shape-tables by keyboard entry, and creating and editing text files have been developed by MECC staff. These utilities aid MECC users in making more efficient use of their microcomputers. A special STARTER program, documented by a MECC publication, the *MECC/APPLE Authoring/Programming Guide*, includes most of the subroutines and utilities necessary to author and produce quality software efficiently.

3) New Development Efforts

Microcomputer capabilities such as graphics, sound, color, and animation have greatly increased the computer's potential as an instructional aid. The MECC community, both staff and users, have already begun development of many new instructional computing packages. Built around the microcomputer, the courseware will take advantage of this new and exciting potential. A comprehensive music theory package of seventeen programs is one example of a new application developed by MECC staff. This package was an impossibility before the graphics and sound capabilities were available. Additional applications, designed to be comprehensive units of study, are presently under development in geometry, elementary reading skills, and middle school science.

Methods of Distribution

Effective instructional use of microcomputers is very dependent upon dissemination of applications programs. The MECC staff has considered a variety of possibilities including tape or cassette shipping, mailing listings, and electronic transfer. While special cases will undoubtedly require the use of a variety of techniques, MECC has decided to use the previously described (see "Software" section) downloading technique as its primary means of disseminating applications programs within Minnesota. The written materials part of the courseware packages will be handled through the MECC Publications Department's order/shipping process.

Among the several methods of distributing microcomputer software, the most widely used method is cassette tape. While inexpensive, this method is time consuming and, on a large-scale basis, may have serious reliability problems. Most educators prefer floppy diskettes over cassettes. This means of distribution, that is, duplicating and mailing diskettes/cassettes solves some problems. Even for the inexperienced user, duplicating diskettes is a relatively simple process. However, the user who wants only three of the 20 programs on a diskette or cassette is forced to buy something unwanted. Program enhancements, which are assumed to be frequent in these early development days, are impossible to keep up with in a large user-group. Simple program replacement probably requires the purchase of a whole new diskette.

Given that MECC already has in place a statewide mechanism for transfer, MECC has chosen to keep a library of APPLE II programs on the timeshare system, and MECC users are now able to download programs to their microcomputers. This process works quite well for some applications. However, others, such as the MECC/APPLE II Music Package, require the downloading of 17 programs. This process can take hours. As a practical matter, such packages may require disk duplication for the initial version while using downloading for enhancements or revisions.

The technology of distributing software through single program ROM cartridges has a bright future. The reliability and protection from unauthorized duplication make this method attractive to commercial vendors. Users are wary of the higher cost of the method and the system's general inability to make program modifications.

With increased availability of software and ease of distribution, duplication and copyright violation problems arise. Schools within an educational cooperative generally have the right to use the software developed for them in the manner they choose. However, schools or individuals purchasing commercial software are not purchasing the right to duplicate or distribute programs. This prohibition holds even within districts or between colleagues. Good quality software is expensive to develop, and microcomputer users cannot expect commercial products to become available unless they are willing to pay. Commercial organizations need educators' encouragement to get into instructional computing courseware development. Educators must provide some encouragement by assisting in protection of software products.

MECC Courseware Distribution Policy

MECC is reviewing the various alternatives for distributing software to educational users throughout the country. MECC has an attractive timeshare system package of applications for sale and has distributed numerous copies. If interested in obtaining the "MECC Software Distribution Policy" booklet, send one dollar ($1.00) to MECC Publications Office, 2520 Broadway Drive, Lauderdale, MN 55113, and ask for publication number 200-1. This booklet lists both the timeshare (CDC-CYBER 73) and microcomputer (APPLE II) software packages available for sale.

Software Summary

Early development of the instructional use of the microcomputer has focused on the ease of use and capability of quickly providing information to users. The microcomputer can only become a significant factor in education if high quality courseware is produced and made available to all users. Teachers will need background information, suggested methods of use, and user guides to help them make effective use of this new teaching/learning tool.

Instructional computing software for microcomputers is expected to become more abundant as protection against duplication increases. Educators looking for high-quality software should examine:

1) courseware packages that include the applications software and teacher/learner support material such as guides, resource booklets, and student worksheets;

2) software that effectively uses the special capabilities of the microcomputer;

3) courseware packages that are stand-alone, comprehensive lessons, or units that can meet the different needs of teachers and students;

4) courseware packages that are well packaged and attractively presented; and

5) courseware packages that include good user documentation.

The availability of high quality, educationally sound courseware for instructional computing will be greatly enhanced by local, state, and national educational decisions addressing the need for incorporating microcomputers into the classroom.

JEM Research

by
JEM Projects

History

Joint Educational Management Research (JEM) is a nonprofit research institute located at the Discovery Park complex on the University of Victoria campus (British Columbia). The title of the organization reflects the early focus of JEM on projects related to educational administration. These projects were commenced at the request of the Minister of Education in 1977, for both field agencies and the central bureaucracy. JEM's work within education in British Columbia has been to undertake initial feasibility studies for the ministry or field agencies and, where appropriate, to act as project manager or project consultant to initiated work. Much of this work has involved computer technology either directly for modeling, in data support systems, or for project planning and control.

Because of the interest within education and the employment marketplace in computer technology, JEM has sponsored several projects related to the need for computer literacy. These include computer science employment forecasts, the use and potential for the implications of microcomputers in computer-aided instruction and learning (CAI), and micro-electronic learning aids. JEM discussion papers on these subjects and related aspects of instructional technology resulted in the Deputy Minister and Senior Superintendent of Schools requesting JEM to embark on a program to bring microcomputers into the schools of British Columbia on a pilot basis.

Current Work

JEM's present activities, while including research assistance in management projects and project planning for educational agencies, are focused on microcomputer technology in the instructional setting. The scope of involvement covers:

1) hardware acquisition and testing;
2) courseware acquisition and testing;
3) creation of discussion papers on related topics;
4) publication of a newsletter on computer-aided instruction (CAI);
5) evaluation of pilot test activities;
6) publication of courseware development standards;
7) operation of an instructional technology coordination centre;

8) courseware development; and
9) coordination of inservice training.

In addition to the above, JEM is engaged in the evaluation of new techniques for applying advanced hardware and software technology to such areas as speech recognition, special keyboards, speech synthesis, animation and graphics, author languages, courseware design, analysis of learning potentials, and education of handicapped children. These activities are conducted in conjunction with the University of Victoria and the National Research Council.

Future

The long-term goal of JEM Research is to enhance the learning process through innovative technology. It is committed to undertake this work utilizing a team of highly skilled research associates with both practical classroom experience and exemplary technical qualifications, in an environment of well-organized individual creative freedom and professionalism.

Part II

Applications of the Microcomputer

Elementary Mathematics and the Computer

by
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JEM Research

This article was first published in Micro-Scope, *Vol. 1, No. 5(November 1980).*

How useful are Computer-Assisted Instruction (CAI) and Computer-Managed Instruction (CMI) in an elementary mathematics program?

In an elementary mathematics program, a significant portion of a teacher's time is spent in monitoring and developing drill and practice activities which are intended to thoroughly acquaint students with newly introduced material and to constantly review the old. In an individualized mathematics program, this involves regularly assessing each student's placement and progress; it means searching through published materials in order to locate exercises and drills that are appropriate to the student's level of skill and ability; where a sufficient quantity of suitable materials is not available, it requires the development and duplication of appropriate materials; and it involves the never-ending corrections and the recording and reporting of each student's successes and failures.

Few elementary teachers would question the importance and value of these activities, but most express concern and frustration over the amount of valuable teaching time that is consumed by drill and practice activities and the paperwork that is associated with an individualized mathematics program. Many would appreciate an alternative method that has been proven instructionally sound and which would reduce the load of paperwork.

CAI and CMI offer teachers such an alternative method. The first step in successful teaching is motivating students; it is evident that students of all ages are motivated by the computer. In the case of a community college system in Ontario, the use of the computer increased the attendance rate of students in remedial or basic mathematics courses from a dropout rate of 60 percent to an attrition rate of only 20 percent with CAI mathematics (Dr.Ludwig Braun, "Computers in Learning Environments, an Imperative for the 1980s," BYTE, July 1980, p.10).

A series of studies on the value of CAI for achievement and time to learn in elementary and secondary education, particularly in the basic skills area, has indicated that augmenting classroom instruction with CAI materials supports the notion that supplementary instruction with

CAI leads to higher achievement than occurs with traditionally taught students (Braun, 1980).

The most recent review of the effectiveness of the use of the computer indicated that when the computer is used to aid instruction in the elementary and secondary school level, the achievement and/or the time reduction to learn materials is significantly improved (Braun, 1980). This covers skills in elementary language arts and mathematics.

CAI has been proven to be instructionally sound both in terms of achievement and in the time required to learn material. A properly designed management system for the computer can drastically reduce a teacher's "paperload."

In a mathematics program, CAI and CMI used together can: assess students' skills and areas of weakness; develop individualized programs through diagnostic and prescriptive procedures; generate traditional worksheets or inexpensively display material electronically; mark assignments; provide students with immediate feedback; offer remediation or enrichment material as appropriate; test students; work out percentages, means, averages, and standard deviations; store students' records; and provide reports on progress.

Generally, the more expensive a CAI or CMI package is, the more sophisticated its functions. But even a simple, inexpensive drill and practice program which presents a question, accepts a student's response, and offers feedback, has its place in an elementary mathematics program and would be a good place for the cautious teacher to start.

For those who are already convinced that the computer is a valuable tool to augment mathematics instruction and management, there are a number of sophisticated but expensive packages on the market. Radio Shack is now offering, for example, the *K-8 Math Program* which provides individualized exercises in addition, subtraction, division, multiplication, and number concepts. One of its features is a placement mode which determines a student's present skill level in terms of the four basic functions of mathematics. The teacher enters a level at which he or she thinks the student should begin, based on a study of the "Curriculum Content Summary" that is provided with the manual. The computer asks the student to work a few problems at that level and placment is made at the appropriate level. The computer will generate drill and practice material that is appropriate and then provide a record for the teacher of how well the student has done based on the number correct on the first, second, or third attempt.

At any point the teacher can ask the computer to test the student. The computer will randomly select as many problems as the teacher chooses from a particular lesson. During testing, the student receives no prompting and has no indication of whether the answers entered are correct or incorrect. At the end of the test, a report shows the number of problems worked, how many were correctly answered, the percentage correct, and the average response time.

SRA's *Classroom Management System* for Grades 4 through 8 provides the teacher with a diagnostic and instructional tool. Utilizing nine survey tests and 49 probe tests, it narrows a student's areas of difficulty down until it can prescribe materials based on 325 objectives and references to six textbooks, 16 SRA kits, and five references which the teacher can include. It keeps a record of each student's progress and will generate a hard-copy report on an individual student or on the entire class.

The system might prescribe SRA's CDIM package which provides computerized drill and practice materials for Grades 4 to 8. Or, teachers can purchase a version which has a management system built into the drill and practice materials.

Milliken's *Mathematics Sequences* incorporates a management system which allows teachers to assign three exercises to each student in as many as five classes. Without requiring any teacher supervision, the student tells the computer his name and it automatically takes him to the assignment his teacher has specified or to his last unfinished assignment. If the student is having too much difficulty, the computer will automatically lower his problem level. It will then produce a hard-copy report which indicates the problem level the student is currently working on, which levels have been successfully completed, and the percentage correct on assignments.

For these CAI and CMI packages to be utilized to their full potential, students need ready and easy access to a microcomputer. At the present time, unfortunately, even one microcomputer per classroom is considered a luxury. Until microcomputers become commonplace in the classroom, teachers will have to be imaginative in working out a schedule which will provide optimum use of the microcomputer.

Students who could benefit the most from using computer materials (perhaps remedial or enrichment students) might be scheduled more frequently than students who work well with traditional teaching methods. Small groups of students might use the computer together, benefiting from the shared problem solving. A very inexpensive, colorful drill and practice program could be used with the whole class as a regular drill each morning. Poorly motivated students could be allowed to use challenging mathematics games, drill and practice in disguise, as a reward for completing assignments. Even if a teacher is determined that each student should have a regular turn, one microcomputer per class of 30 would allow each child to have a session every three days. Whatever plan the teacher chooses, by allowing the microcomputer to do what it does best, it is freeing the teacher to do what he or she does best in innovative, creative, and experimental teaching.

Heuristic Problem Solving and the Microcomputer

by
Pat Hyde

Teacher
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The microcomputer is an exciting new educational tool with which mathematics and heuristic problem solving can be taught. Programming should not be taught for its own sake. Rather, it should be taught as required to enhance students' problem-solving skills.

I have been making a collection of problems suitable for Grades 4, 5, and 6 which can be solved using the microcomputer. Each problem consists of a number pattern which must be understood before a program can be written.

The teaching lessons developed to accompany each problem are based on Polya's problem-solving steps:

1) Understand the problem

Some of the strategies which may be appropriate include:

- making a table
- conducting an experiment
- making an organized list
- separating the parts
- recognizing the pattern
- thinking of a simpler problem

2) Make a plan

This is the first step at which we consider using the microcomputer to continue the number pattern we have discovered.
Make a flowchart and/or plan the output you expect to see on the screen or printer.

3) Carry out the plan

Translate your plan into a computer program and run it. Only a few commands in BASIC are required to write programs for any of the problems since programming is not the main objective. Most require knowledge of variables, PRINT, IF_THEN, FOR...NEXT. Some require INPUT and GOSUB.

4) Looking back

Can you improve your program?
What did you learn by solving this problem?
Could you have solved it differently?
Can you extend the problem?

The students have used Polya's four steps to organize their write-ups too.

Some of the problems in the set follow.

1) Write a program that will continue this number pattern:

3, 9, 27, 81, 243, . . .

2) How many telephone numbers can there be that start with the same first three digits as yours?
Write a computer program to do the work for you.

3) If you start saving money with one cent on the first day, two cents on the second day, four cents on the third day, eight cents on the fourth day, and so on for 30 days, how much money will you have saved?

4) If each of four people shakes hands once with each of the other three, how many handshakes will there be? How many if there are five people? Write a program that will ask the user how many people there are and tell him how many handshakes there will be.

5) How long would it take to spread a rumor in a town of 80,000 people if each person who hears the rumor tells it to three new people within 15 minutes?

6) Write a program that will continue this number pattern:

```
        1 x 8 + 1 = xxx
       12 x 8 + 2 = xxx
      123 x 8 + 3 = xxx
              .
              .
              .
123456789 x 8 + 9 = xxx
```

Your program should let the user predict some numbers in the pattern. The computer should check the answer and give the user an appropriate message.

7) In the song "The Twelve Days of Christmas," gifts are given to the singer in a definite pattern. Write a program to figure out how many gifts there were altogether.

Mathematics, Education, PLATO, and Some Thoughts On the Future

by
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University of Alberta

Overview

This brief article will review some of the mathematics materials currently available on the PLATO* system. In addition, some general issues related to mathematics education and computer-based instruction (CBI) will be addressed to provide thought-provoking ideas for future consideration. The article will begin with several of the author's biases, proceed with a discussion of PLATO CBI, move to math lessons on PLATO, and conclude with some thoughts on the future.

Author's Biases

Bias #1

Educators have not begun to scratch the capabilities of CBI technology in the learning environment. There is far more technological power than has been applied pedagogically. The two primary reasons are that CBI is poorly understood, and developing challenging lessons of quality places heavy time demands on classroom teachers.

Bias #2

Computers in schools will not simply be another technological "flash in the pan"; instead, they will eventually revolutionize the education process. The reason is that of all the instructional technology to be developed, the computer stands alone in the capability to interact with the learner on an individualized basis. All other media transmit information to a group while the computer is capable of interacting with an individual. Student learning is significantly increased by emphasizing processing over reception learning.

Bias #3

The coming of CBI will be a revolution rather than an evolution. Educational innovation takes 50 years to become used on a widespread basis; high technology takes 20 years. Since CBI is a blend of educational and high technology, one can expect full acceptance between 20 and 50

* PLATO® is a registered trademark of Control Data Canada, Ltd.

years after discovery. It is significant that PLATO is approximately 20 years old at this writing.

PLATO

When evaluating any CBI project, one must consider these five factors: personnel, software, courseware (instruction to be delivered), hardware, and telecommunications. The PLATO system is the only major CBI system with these features that was designed specifically to be used in the instructional process. As an example, the PLATO terminal is human engineered for high-quality instruction. It includes such features as high-resolution interactive graphics, touch panel, special function keys (for example, the HELP key), and built-in intelligent microprocessors.

The University of Alberta purchased and has operated a PLATO system since autumn, 1980. It is used to deliver and prepare CBI for the university and educational institutions across the province. A major reason for the selection of PLATO is its superb software facility that supports the development of courseware. Fifteen projects to develop university courseware are currently under way.

The university PLATO system is one of five university-based installations in North America. Together, they serve over 250 colleges and universities. Many of these institutions are actively engaged in courseware development across hundreds of subjects and all grade levels. Control Data is developing an extensive body of courseware which it markets to educational and training institutions. Mathematics for junior high, senior high, and university level training enjoys special attention in the total courseware list. It is estimated that there are 20,000 hours of courseware available across all PLATO installations worldwide. Courseware development of this magnitude represents a significant investment of human and machine capital, and will affect education and training.

Mathematics on PLATO

Due to the decentralized nature of the development of mathematics (and other courseware) lessons, it is impossible to know the number of lesson hours currently available. My estimate is 2,000 hours = 500.

In a completely nonrandom sample search, I signed on to one of the several of PLATO's on-line catalogs to request information on mathematics lessons. Figure 1 lists the lesson titles found on initial search. One can see the extent of material uncovered by this highly limited search.

Each entry is arranged in a tree-structure format such that typing in the number will display additional information about the lesson topics. For example, additional information on the topic "Mathematics, elementary, Academic Library" (Figure 1, entry no. 50) resulted in the extended listing found in Figure 2. After 20 lessons, I discontinued the search and requested more detailed information on the lesson "Decimal Darts" (Figure 2, entry no. 20). Figures 3a and 3b present detailed information on "Decimal Darts" including lesson information, intended audience, description, and goal. Finally, I signed on to the "Decimal Darts" lesson. A sample of the interaction is shown in the sequence of Figures 4a - 4e.

In Figure 4a, the PLATO program (actual screen display) presents a vertical number line with balloons. The student is to type in the decimal value of the location of each balloon in the lower left-hand corner of the screen. In Figure 4b, I typed in ".11" and pressed the NEXT key. A dart moved across the screen and stuck at position ".11" (see Figure 4c).

At this point, I exercised the option of having PLATO shoot a dart (see text, lower right-hand, Figures 4a - 4c). The result was a dart which stuck at ".103," Figure 4d. Finally, a dart was shot at ".15," resulting in the bursting of a balloon, Figure 4e.

This practice assists a student in interpolating positions on a number line. Furthermore, the difficulty of the problem can be varied under program and/or student control. When finished, the student receives a summary of his or her performance with the option to continue practice.

Some Thoughts on the Future

Goals of Mathematics

Two broad goals of teaching mathematics include the learning of mathematics per se and the learning of logic, an organized way of thinking about the world. Current mathematics instruction, with its instructional strategies of tutorials, simulation, review and drill, games, and diagnostic/prescriptive testing/record keeping has focused almost exclusively on the former goal. Microcomputers in education will certainly enable us to focus on the development of logical skills. *Mindstorms* by Seymour Papert reports on a major project to do the latter using computers with young children.

Three proposed benefits from Papert's work will be cited. First, the student will learn to debug programs. The significant point here is that errors and mistakes will not be viewed as failures but rather as challenging problems to be solved. Second, students will come to use the power of recursive functions and integrate loops in their thinking about other forms of math-related operations. Third, learners will become more prone to do intuitive error checking to estimate the reasonableness of their work. By contrast, the error checking that is driven by discovering that one division problem in 20 does not have an integer quotient is a false, human error check.

Curriculum Goals

Papert has argued that much of what is taught today is dictated by the limits of paper and pencil technology. Plotting of quadratic equations and long division are two examples. The imminent availability of cheap computing technology will eliminate the need to do these computations by hand. A pressing question for educators is what new curriculum components should be added to replace these existing skills. This topic is expanded in the following section.

Demise of Schools

Papert and others (for example, Lewis, 1980) have predicted that the presence of computers in our society will enable us to modify the total learning environment of the student in such a way that schools as they currently exist ". . . will have no place in the future" (Papert, 1980, p. 9). Such predictions are extremely unclear as to whether schools will simply wither away or whether they will evolve by transforming themselves into something new.

I believe that economic arguments, not a major factor in education to date, will cause the above prediction to come to pass. Education is becoming big business, computer costs are rapidly dropping, and the labor-intensiveness of education is raising the costs to new heights. Only the wealthiest of nations will be able to afford a labor-intensive system of education in the future.

Summary

A brief overview of mathematics lessons on PLATO and a look at the future have been presented. Whatever happens, it is clear that educators must become extremely active and knowledgeable to be able to tame this technology and direct it in ways that are good for society. Or, to put it the way a friend of mine does, "The view changes only for the lead dog."

References

Evans, C. *The Micro Millenium.* New York: Pocket Books, 1979.

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

Figure 1. Sample Titles of Mathematics Lessons From One PLATO On-Line Lesson Library.

Subject Index

1. Mathematical aspects. Calculation. Policies. Life ins.

   Mathematical logic
   see also

2. Set theory

3. Mathematical models
   Population. Growth

   Mathematical programming
   see also

4. Linear programming

   Mathematics
   see also

5. Algebra

6. Arithmetic

7. Calculators

8. Calculus

9. Combinations. Mathematics

10. Boolean algebra

11. Set theory

12. Sets. Mathematics.
    Distributive law

13. Short term financing

14. Signed numbers

15. Addition

16. Addition and multiplication

17. Addition and subtraction

18. Division

19. Multiplication

20. Subtraction

21. Signed numbers

22. Simplification. Equations

Mathematics *see also*

23. Coordinates

24. Dimensional analysis

25. Equations

26. Factors

27. Fourier series

28. Functions. Mathematics

29. Geometry

30. Graphs

31. Matrices

32. Numbers

33. Numerical Analysis

34. Numerical methods

35. Permutations

36. Probability theory

37. Ratios

38. Statistical analysis

39. Trigonometry

40. Vectors. Mathematics

41. Mathematics

42. Arrays -- for elementary students

43. Mathematics

44. Sets. Distributive law

45. --for adult basic education

46. --for chemistry

47. --games

48. MATHEMATICS, advanced. Academic Library

49. MATHEMATICS, advanced. Plato support library

50. MATHEMATICS, elementary. Academic library

51. MATHEMATICS. Basic skills library

52. MATHEMATICS. General Ed. Dev. Library

Matrices
see also

53. Simultaneous equations

54. Matrices. Fortran language. Program languages. Multiplication

*** NEXT for more ***

Figure 2. Sample Lesson Titles From Mathematics, Elementary, Academic Library.

Subject List Index

Subject:
MATHEMATICS, elementary. Academic library

1. Add and subtract with equivalence sets
by Sharon Dugdale, David Kibbey, Helen Leung, Plato Mathematics Project
FILENAME: Oslad2 LIBRARY TYPE: B1

2. Adding fractions
by Keith Bailey, Community College Math Group
FILENAME: Oaddfrac LIBRARY TYPE: B1

3. Addition and subtraction
by Sharon Dugdale, David Kibbey, Tom Layman, Plato Mathematics Project
FILENAME: Otryad LIBRARY TYPE: B1

4. Addition of signed numbers
by Tamar Weaver, Community College Math Group
FILENAME: Osignadd LIBRARY TYPE: B1

5. Addition practice, simplifying answers
by Sharon Dugdale, David Kibbey, Barry Cohen, Plato Mathematics Project
FILENAME: Opad1 LIBRARY TYPE: B1

6. Addition with equivalence sets
by Sharon Dugdale, David Kibbey, Helen Leung, PLato Mathematics Project
FILENAME: Oslad LIBRARY TYPE: B1

7. Areas and multiplication
by Esther R. Steinberg, Saul Way
FILENAME: Ozareas LIBRARY TYPE: B1

*** NEXT for more ***

Type a number for more information >>

NEXT to move SHIFT-BACK to exit

Figure 2. (Cont'd)

Subject List Index

Subject:
MATHEMATICS, elementary. Academic library

8. ASK: a twenty question type of game for guessing a number
by Esther R. Steinberg
FILENAME: 0erswk LIBRARY TYPE: B1

9. Beehive
by Sharon Dugdale, David Kibbey, Helen Leung
FILENAME: 0bees LIBRARY TYPE: B1

10. Boxes: equivalent fractions
by Sharon Dugdale, David Kibbey, Marilyn Bereiter,
PLato Mathematics Project
FILENAME: 0receqa LIBRARY TYPE: B1

11. Boxes: equivalent fractions practice
by Sharon Dugdale, David Kibbey, Marilyn Bereiter,
FILENAME: 0receqb LIBRARY TYPE: B1

12. Boxes: how much is painted?
by Sharon Dugdale, David Kibbey, Marilyn Bereiter,
Plato Mathematics Project
FILENAME: 0recask LIBRARY TYPE: B1

13. Boxes: name equivalent fractions
by Sharon Dugdale, David Kibbey, Marilyn Bereiter,
Plato Mathematics Project
FILENAME: 0recnams LIBRARY TYPE: B1

14. Candy factory
by Sharon Dugdale, David Kibbey,
FILENAME: 0candy LIBRARY TYPE: B1

*** NEXT for more ***

Type a number for more information >>

NEXT to move SHIFT-BACK to exit

Figure 2. (Cont'd)

Subject List Index

Subject:
MATHEMATICS, elementary. Academic library

15. Candy warehouse:
by Sharon Dugdale, David Kibbey, Tom Layman
FILENAME: Ocandywh LIBRARY TYPE: B1

16. Checkup: cut and paint
by Sharon Dugdale, David Kibbey, Marilyn Bereiter, Plato Mathematics Project
FILENAME: Orecchk LIBRARY TYPE: B1

17. Checkup: pizza fractions
by Sharon Dugdale, David Kibbey, Helen Leung, Plato Mathematics Project
FILENAME: Opchk LIBRARY TYPE: B1

18. Cut and paint & fraction notation
by Sharon Dugdale, David Kibbey, Marilyn Bereiter, Plato Mathematics Project
FILENAME: Orec LIBRARY TYPE: B1

19. Darts
by Sharon Dugdale, David Kibbey, Barry Cohen Plato Mathematics Project
FILENAME: Odarts LIBRARY TYPE: B1

20. Decimal darts
by Sharon Dugdale, David Kibbey, Helen Leung, Plato Mathematics Project
FILENAME: Oddarts LIBRARY TYPE: B1

*** NEXT for more ***

Type a number for more information >>

NEXT to move SHIFT-BACK to exit

Figure 3a. Description of "Decimal Darts" Lesson.

Decimal Darts

BY: Sharon Dugdale, David Kibbey, Helen Leung,
Plato Mathematics Project
University of Illinois

COPYRIGHT DATE: 1977 FILENAME: Oddarts
LIBRARY TYPE: Academic

This learning activity is part of the fractions curriculum developed by the PLATO Mathematics Project at the University of Illinois. The exercise consists of a vertical number line with balloon illustrations placed at different locations. To burst the balloons, students must enter the decimal fraction that corresponds to the position of each balloon on the line.

(a) Further Information (b) Authors

Press the letter of the option you wish to select.
>>

LAB to try this item
SHIFT-NEXT/SHIFT-BACK to move BACK to exit

Figure 3b. Expanded Description of "Decimal Darts" Lesson

Further Information

ESTIMATED LENGTH: 30-45 minutes
100% CAI

INTENDED AUDIENCE: Elementary math students

DESCRIPTION:

This learning activity is part of the fractions curriculum developed by the Plato Mathematics Project at the University of Illinois. The exercise consists of a vertical number line with balloons placed at different locations. The distance between the numbers on the vertical line and the size of the balloons determines the complexity of the problem. To burst a balloon the student must be able to enter the decimal fraction corresponding to the position of the balloon on the line. Difficulty adjusts to the student's performance. Numbers are entered on a trial-and-error basis and the balloons may be burst in any order until there are no balloons left on the line. The exercise may be carried out with or without negative numbers.

GOAL:

Give practice locating decimal numbers on the number line.

Press NEXT to return to options

BACK-go to previous page
LAB to try this item

SHIFT-BACK go to options index

Figure 4a. Screen Display for "Decimal Darts" Lesson.
Student is to estimate location of balloons on a vertical number line.

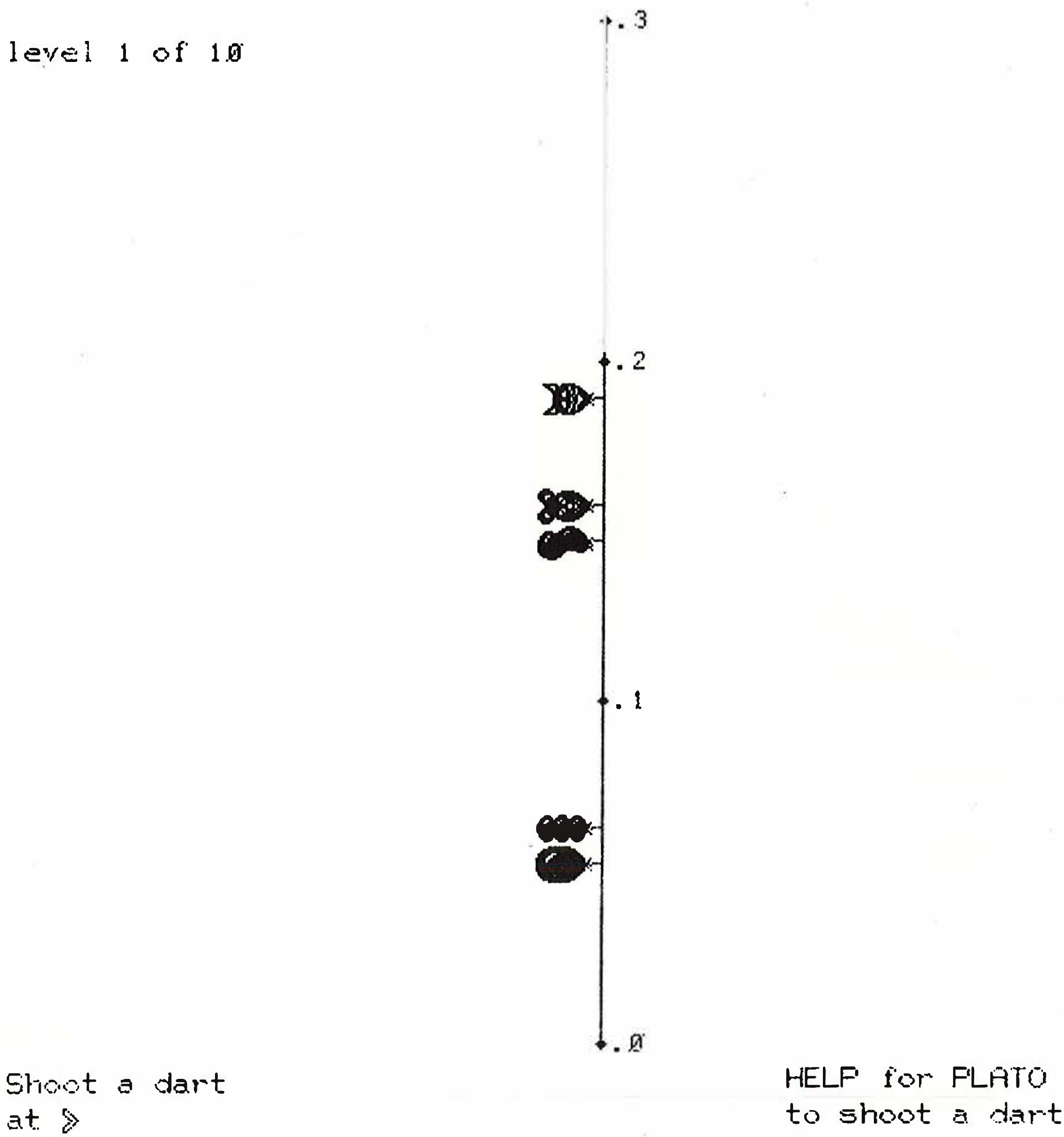


Figure 4b.
The student estimates a balloon to be located at "0.11" by typing the number at the lower left-hand corner of the screen.

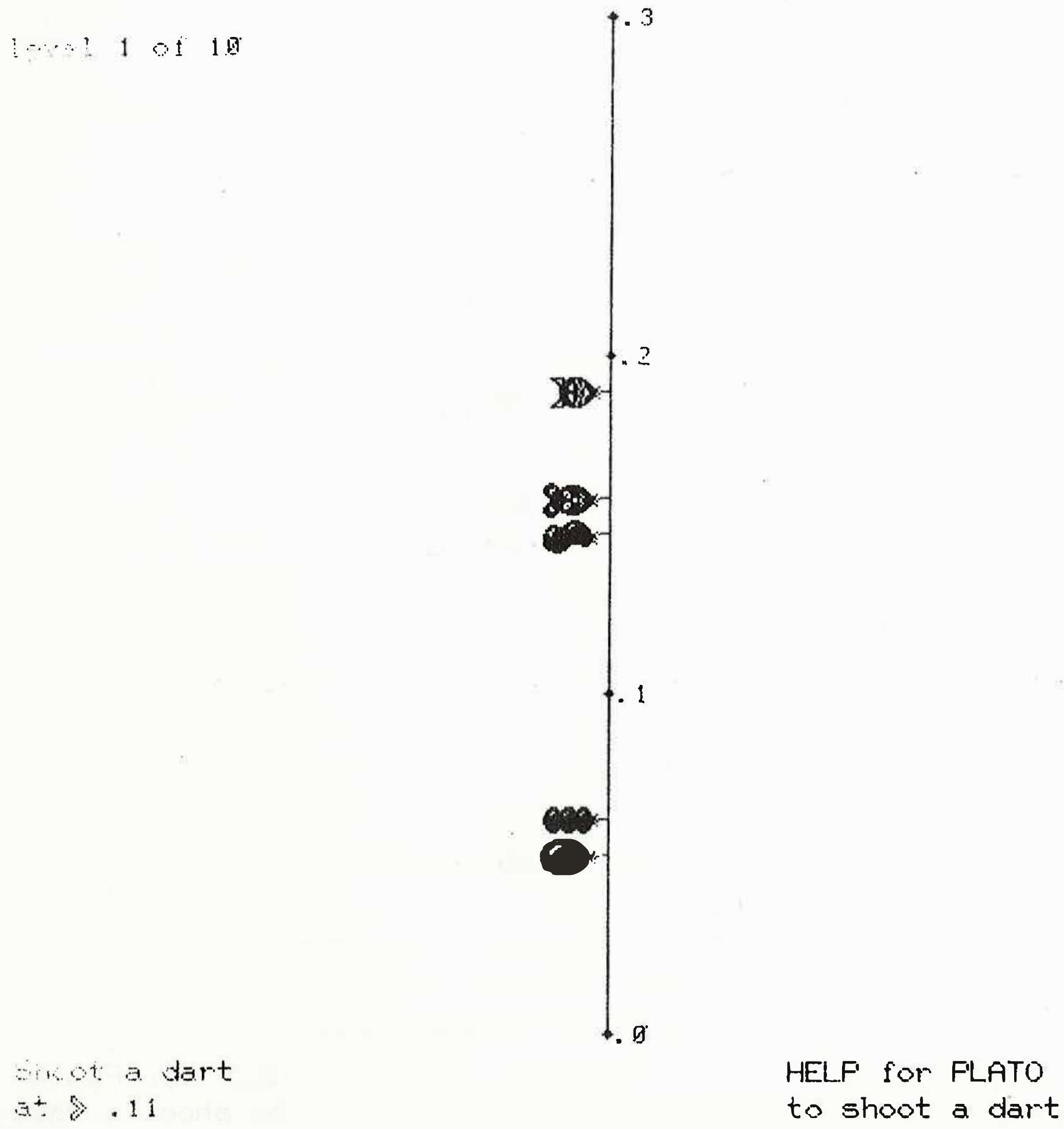


Figure 4c. PLATO Shoots a Dart at Position "0.11."
The student receives feedback on his estimate to use in refining his next estimate.

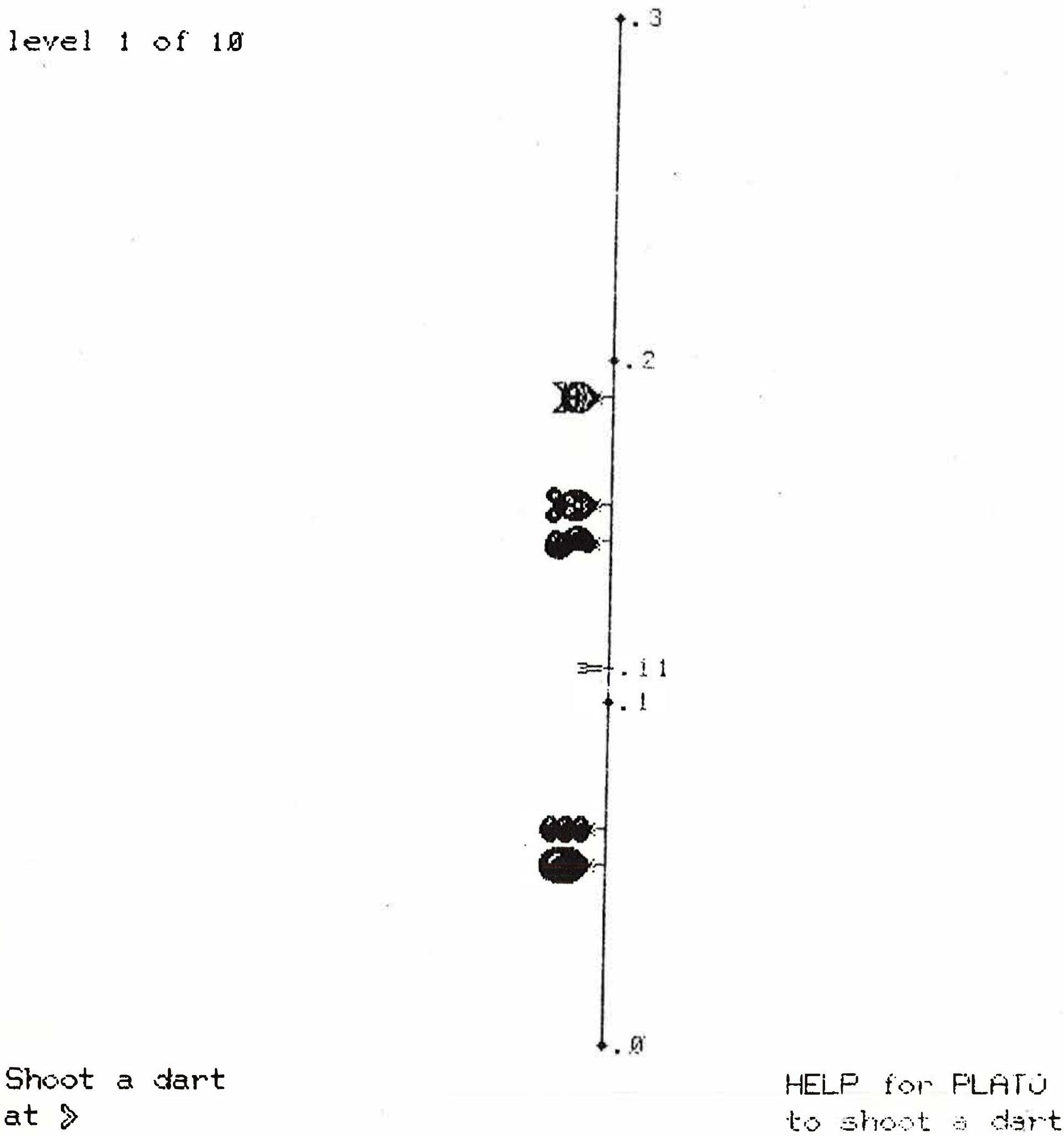


Figure 4d.
The student asks PLATO to shoot a dart by pressing the HELP key.
PLATO's dart strikes at ".103."

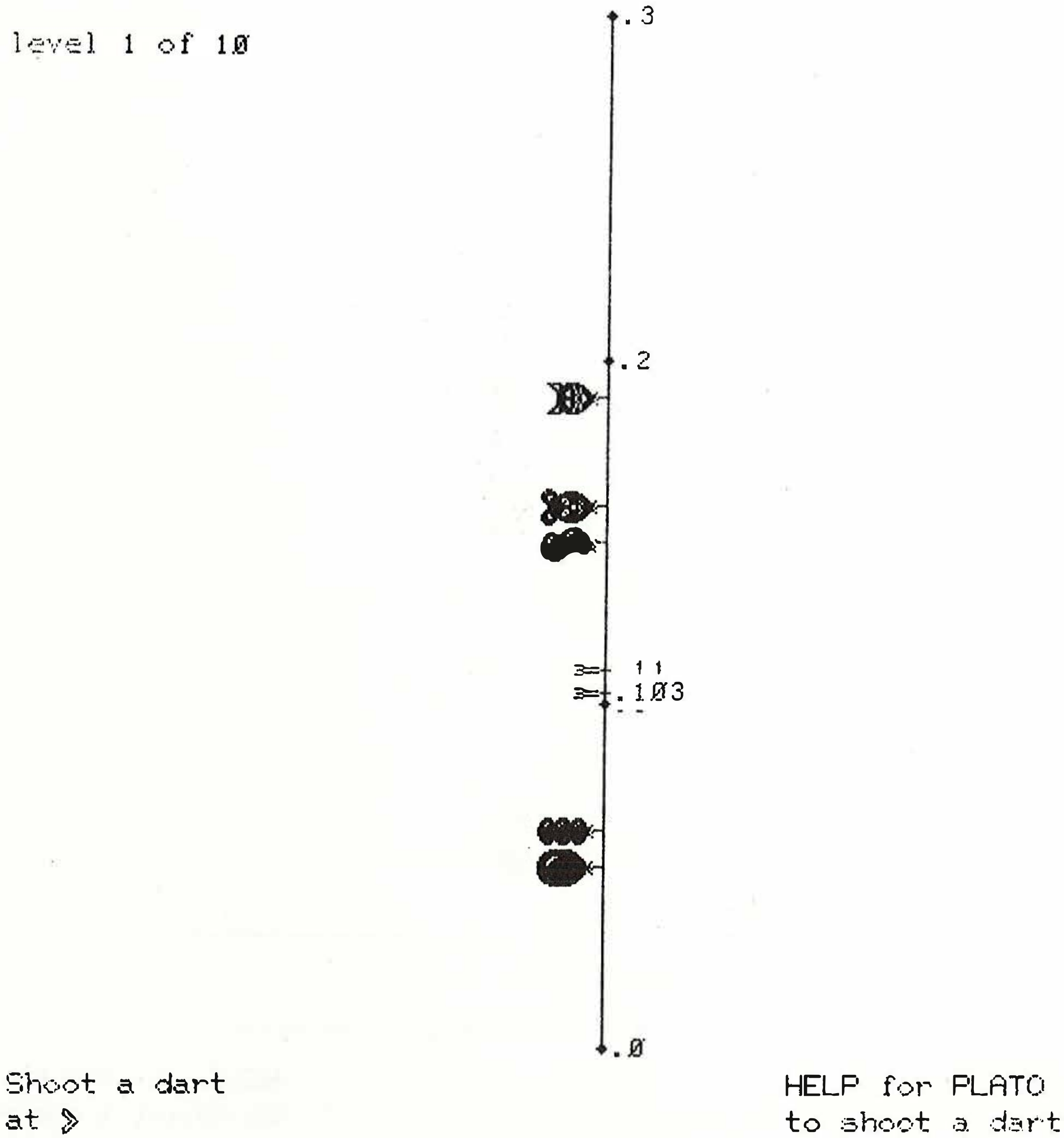
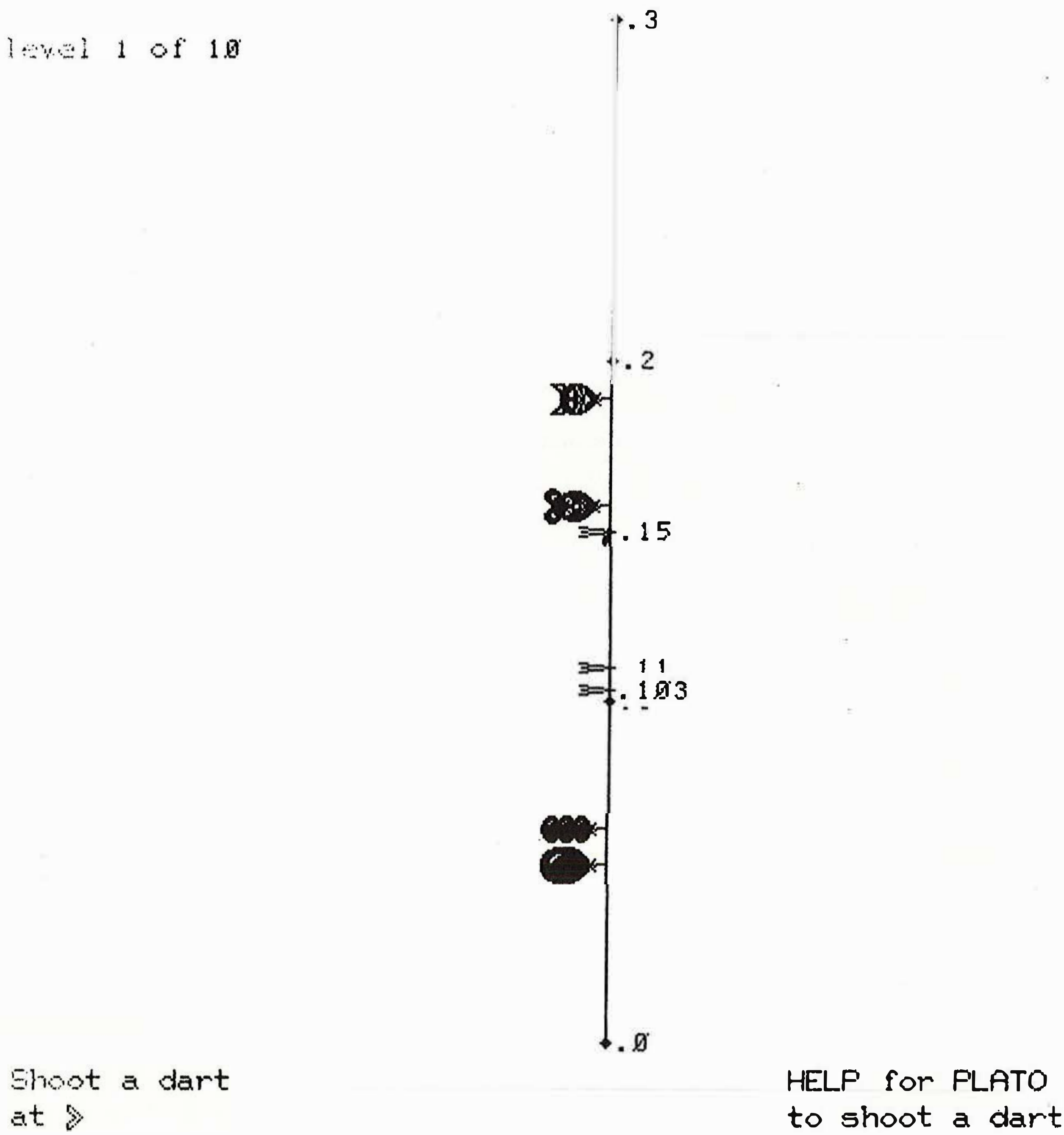


Figure 4e.
The student chooses "0.15." The balloon at that position is burst by the dart, confirming the accuracy of the choice. The total sequence will continue until all balloons are burst at which time the student can opt to have another set, change the difficulty, or proceed to a different lesson.



Agenda for Action: Recommendations for School Mathematics of the 1980s

National Council of Teachers of Mathematics

Editor's Note - *The* Agenda for Action, *published in April 1980, had eight recommendations. Recommendation three deals with the use of calculators and computers in the classroom of which the specific reference to computers is of interest here.*

Recommendation 3

Mathematics programs must take full advantage of the power of calculators and computers at all grade levels.

Beyond an acquaintance with the role of computers and calculators in society, most students must obtain a working knowledge of how to use them including the ways in which one communicates with each and commands their services in problem solving.

The availability of computing aids, including computers and calculators, requires a reexamination of the computational skills needed by every citizen. Some of these computational skills will no longer retain their same importance, whereas others will become more important.

It is recognized that a significant portion of instruction in the early grades must be devoted to the direct acquisition of number concepts and skills without the use of calculators. However, when the burden of lengthy computations outweighs the educational contribution of the process, the calculator should become readily available.

With the increasing availability of microcomputers at decreasing costs, it is imperative that schools play an active part in preparing students of the 1980s to live in a world in which more and more functions are being performed by computers.

Recommended Actions

3.1 *All students should have access to calculators and, increasingly, to computers throughout their school mathematics program.*

Schools should provide calculators and computers for use in elementary and secondary school classrooms.

Schools should provide budgets sufficient for calculator and computer maintenance and replacement costs.

3.2 *The use of electronic tools such as calculators and computers should be integrated into the core mathematics curriculum.*

Calculators should be available for appropriate use in all mathematics classrooms, and instructional objectives should include the ability to determine sensible and appropriate uses.

Calculators and computers should be used in imaginative ways for exploring, discovering, and developing mathematical concepts and not merely for checking computational values or for drill and practice.

Teachers should ensure in their classroom management that the use of computers by individual students in isolated activity does not replace the critical classroom interaction of students with peers and teachers. The healthy give-and-take of group work and discussion, which promotes values of communication, cooperation, empathy, mutual respect, and much of cognitive development, remains essential.

3.3 *Curriculum materials that integrate and require the use of the calculator and computer in diverse and imaginative ways should be developed and made available.*

Schools should insist that materials truly take full advantage of the immense and vastly diverse potential of the new media. In particular, developers of software should be cautioned that just to use conventional material and techniques newly translated to the medium of the computer will not suffice.

Educators should take care to choose software that fits the goals or objectives of the program and not twist the goals and developmental sequence to fit the technology and available software.

3.4 *A computer literacy course, familiarizing the student with the role and impact of the computer, should be a part of the general education of every student.*

In cooperation with schools and professional teacher organizations, funding agencies should support the development of courses in computer literacy for both junior and senior high school levels.

All mathematics teachers should acquire computer literacy either through preservice programs or through inservice programs funded by school districts in order to deal with the impact of computers on their own lives and to keep pace with the inevitable sophistication their students will achieve.

Colleges should provide courses for both preservice and inservice education in computer literacy, programming, and instructional uses of calculators and computers.

Professional organizations should provide information through their various media, conferences, workshops, and seminars to aid in the inservice education of teachers in uses of the calculator and computer.

3.6 *Secondary school computer courses should be designed to provide the necessary background for advanced work in computer science.*

Curriculum design should provide the required foundation for those students who will be involved in careers that increasingly demand advanced computing skills and applications of computing and for those students who will go on to deeper study in frontier fields of computer development.

3.7 *School administrators and teachers should initiate interaction with the home to achieve maximum benefit to the student from the coordinated home and school use of computers and calculators.*

Criteria should be developed to assist parents and school personnel in their selection of home/school computing hardware.

Professional organizations of teachers, mathematicians, and computer scientists should develop guidelines to aid schools, teachers, and parents in the selection of educational software.

The uses of technological devices such as calculators, computers, video disks, and electronic games in the home and other out-of-school places should be anticipated. Programs should be planned that will encourage the positive and educationally beneficial use of these devices.

As home computers come into wider use, homework should be assigned that can take advantage of their potential in problem solving.

3.8 *Educational users of electronic technology should demand a dual responsibility from manufacturers: the development of good software to promote the problem-solving abilities of the student and, eventually, the standardization and compatibility of hardware.*

3.9 *Provisions should be made by educational institutions and agencies to help in the necessary task of educating society's adults in computer literacy and programming.*

3.10 *Teachers of other school subjects in which mathematics is applied should make appropriate use of calculators and computers in their instructional programs.*

3.11 *Teacher education programs for all levels of mathematics should include computer literacy, experience with computer programming, and the study of ways to make the most effective use of computers and calculators in instruction.*

3.12 *Certification standards should include preparation in computer literacy and the instructional uses of calculators and computers.*

Part III

The Microcomputer in Western Canada

Microcomputers in Alberta Schools

by
Milton Petruk

Professor
University of Alberta

The study I completed for Alberta Education was conducted to provide a status report describing the nature and extent to which microcomputers have been introduced into Alberta schools. Data for the study were collected by mail survey of every school in Alberta.

The results showed that nearly 12 percent of Alberta schools now have one or more microcomputers. The majority of the units are Commodore PETs (45 percent), APPLE IIs (31 percent), and Radio Shack TRS-80s (19 percent). They appear to be uniformly distributed across all grade levels. The most frequently reported uses of the microcomputer involve the teaching of computer literacy and computer-assisted instruction. The majority of microcomputer users in the schools expressed the need for additional equipment, software, and training.

While a relatively small number of schools reported that they had no interest in introducing microcomputers into their schools, the majority of schools that do not now have a microcomputer are anticipating getting one or more in the future. However, a large proportion of this group felt that they did not know enough about microcomputers to anticipate what their needs might be. The remainder tended to report a strong need for information about both equipment and programs as well as a strong need for additional training. Many felt the need for leadership, direction, and funding from the Alberta Department of Education.

Microcomputers in British Columbia Schools

by
W. Tennant

JEM Projects

In the spring of 1979, under the direction of the Ministry of Education, Science and Technology's JEM (Joint Educational Management) Projects group, an analysis of the trends in computer-aided learning was commissioned. This investigatory work was conducted by Dr. Mary Westrom at the University of British Columbia and Mr. Bill Goddard. Since that time, extensive dialogue and accelerated analysis have taken place related specifically to the use of the microcomputer as an instructional aid. This work is still going on, while at the same time activity in individual schools is increasing rapidly. There are now several schools with microcomputers installed and being used either actively or experimentally in a classroom setting and more than a dozen machines on order. This will escalate rapidly as experience is gained.

In order for the decisions regarding purchase of such equipment to be made in a knowledgeable manner, the following material is presented as an aid to decision making. It is based largely on the experience of the State of Minnesota which has been exploring this subject for some time and is quite advanced compared to British Columbia in the coordinated use of microcomputers. It is based also upon the recommendations of British Columbia teachers active in microcomputer use in the classroom and upon the ideas of members of the British Columbia Computers in Education Committee (BCCEC) who are active in this field.

The Current Situation

Our present situation in British Columbia is similar to that in other provinces and states. That is,

1) Educator interest in microcomputers is very high;
2) Educator expectations of the role and potential of the microcomputer probably exceed the current capability of the machines;
3) The costs of equipment varies greatly;
4) Both the quantity and quality of educational courseware remains low at present;
5) Audiovisually enhanced (sound and color-graphics) equipment is providing the most innovative thrust;

6) Lower hardware costs have been eroded by a tendency to purchase more peripheral devices;
7) While initial sales and installations are impressive when contrasted with the past four to five years, educational use will follow industry leading to greatly accelerated use in the next two years;
8) Software (courseware) development will not keep pace with the use of the hardware for some time. Much current innovative work will be isolated, not of commercial value, and not readily transferable between machines; and
9) Of the currently available courseware, some is outstanding as a tool to augment instruction.

Uses

The uses which currently look the most promising are the following:

1) The computer can be used as an audiovisual device. In this mode, the teacher uses the device much as an overhead projector; one device is used for a class, perhaps driving several color TV monitors. The teacher uses a black and white monitor and guides the courseware via console as the session progresses. The courseware may be for direct teaching (for example, algebra or music), for a drill and practice style, or for a simulation.
2) The computer will be used on an individually paced basis, usually by one student at a time, for remedial drill or practice while the rest of the class is participating in traditional instruction.
3) The computer will be used on an individually paced basis, usually by one student at a time, for enriched study while the rest of the class is participating in traditional instruction.
4) The computer is used as a terminal to access other centrally located programs such as student career guidance information on an individual basis.
5) The computer is used for school administrative processes such as student records or miscellaneous non-direct-instructional (administrative) applications.
6) The computer is used to teach computer literacy and computer science.

Of these, the first approach currently shows by far the greatest return in terms of value to the learning process in the short term.

Support

At present in British Columbia, there is no formal field support for microcomputers. There is a need for: instructional coordination and training; curriculum integration; courseware development, testing, and purchasing; user workshops; courseware exchange services; hardware purchase and service; central question-answering; and advanced applications research. These areas are under investigation, but it is recognized that it will not be practical to provide this support for several varieties of equipment.

In selecting high-quality software, you should examine: if courseware packages include teacher/learner support materials (for example, guides, resource books, and worksheets); if software uses the full capabilities of your computer;

if courseware units stand alone as comprehensive lessons or units which can meet differing needs of teachers and students; if presentation is attractive and professional; and what number of applications can be expected to be developed for your hardware.

This is expected to improve rapidly with the volume of use over the next two years. The sophistication of the courseware will increase rapidly, as well. Some current models (for example, MECC's music software) are close to spectacular, and still improving. The value of some of this courseware in the inductive process has not yet been comprehensively assessed, but early informal reviews are extremely encouraging.

New advances in hardware and software are expected to provide voice input and output, and integration with video cassette or video disk material.

Computers in Saskatchewan

by
George Odegard

Head of Small Computer Division
Saskatchewan Computer Utility Corporation

Despite several efforts which originated in the middle 1960s, computers did not make any widespread impact on the instructional mosaic of the province until the advent of locally available independent microcomputer configurations in 1978. These reliable and reasonably powerful devices provided the opportunity for rapid expansion and development of existing programs well as the opening of untried areas.

A case in point is the experience of the Saskatoon Board of Education. The elementary section (a K-8 structure with approximately 15,000 students) started a program of instruction about the computer to a small group of students in 1968. Limited access was obtained to a minicomputer situated at the University of Saskatchewan. Staff inservice was organized, and by 1975, students participated at the Grades 7 and 8 level in 12 schools. During this time the curriculum was formalized, and there was a willingness and a readiness to expand the program. However, it was impossible to expand further without the development of an instructional computing centre with its high initial costs and significant ongoing expenses, because computing resources outside the school system were, and are, almost fully utilized. Through a cost-sharing plan between the local school and the Superintendent's Department, individual schools started to purchase microcomputers in 1978, and other schools were given access to microcomputers on a rotational basis. By the end of the 1980-81 school year, three quarters of the 45 schools in the section owned an APPLE II microcomputer equipped with 48k RAM, a disk drive, and a color TV with many schools owning a printer and a locally designed APPLE Cart. All graduates of Grade 8 in 1981 had completed a 35 hour computer literacy course. (Outlines for this and other computer courses follow this article.)

Developments in the secondary section of the Saskatoon Board of Education paralleled those in the elementary section. By the end of the 1980-81 school year, all of the seven secondary schools had a computer laboratory and offered a 100-hour course in computer science. Four of these schools will pilot a second 100-hour course in 1981-82 (see course outline).

At the provincial level, in the spring of 1979, SaskComp (the provincial computer utility) organized a meeting of interested educators to discuss possible directions. Based on that meeting an ad hoc committee was formed, charged with the responsibility of investigating the area of action proposals. This group called a meeting of interested educators in January 1980 and the Saskatchewan Association for Computers in Education (SACE) was formed. Based on the recommendations of the ad hoc committee, SACE produced the SACE *Bulletin*, formed various subcommittees to continue investigations, and sponsored a successful fall conference in October 1980. At time of writing, the next SACE conference is scheduled for October 16/17, 1981 at Saskatoon.

The Saskatchewan Department of Education has been following these developments closely and has implemented plans to form curriculum committees to investigate curricula in the areas of computer science, computer literacy, and business education.

The universities in Saskatoon and Regina are developing courses in computers in education. The Saskatchewan Teachers' Federation (STF), in combination with SaskComp, is sponsoring a number of special workshops for teachers. Ten such short courses were offered in August 1981.

In conclusion, educators in Saskatchewan are responding vigorously to the challenge of computers. Computer science, computer literacy, and computers as a component of business education and electronic technology are instructional opportunities available to students in an ever-growing number of centres. Applications such as computer managed/assisted instruction, teacher/administration tasks, guidance, and correspondence-school uses are just beginning.

Course Outline: Computer Literacy

Saskatoon Board of Education

General Information

(a) The name of the course is "Computer Literacy."

(b) Students enrolled in regular Division III classrooms should take Computer Literacy in Grade 7, Grade 8, or in a combination of the two grade levels.

(c) A total of 35 hours of class time is required to adequately present the course.

(d) The Computer Literacy program will follow the guidelines as set out by the Superintendent of Schools, Elementary.

(e) The principal will have the responsibility for approval of all uses of the computer in his school, in accordance with the guidelines set out by the Superintendent of Schools, Elementary. If uses outside the scope of the Computer Literacy course are considered, the principal will provide the Superintendent of Schools with the details, in writing, of the proposed usage.

Resource Materials

There are a variety of resource materials available. The following books are recommended:

(a) Core

Computer Literacy, Kindrachuk, McKenzie, Frazer-Harrison, and Shih.
- available through the Textbook Centre
- this is an approved resource book for the teacher dealing specifically with flowcharting and programming in BASIC.

ii) *Computer Literacy* (Worknotes), Kindrachuk, McKenzie.

- this is approved student material complementing the *Computer Literacy* text.

(b) Supplementary

i) *BASIC and the Personal Computer* (Addison-Wesley)

- this book provides more information on the BASIC language than required by students taking Computer Literacy, but it is a useful reference book for the BASIC used on microcomputers.

ii) *Computers and Society* (SRA)

- this provides a wealth of information, and discussion is provided on the impact of computers on society.

- it is a college-level book.

Course Content

(a) Introduction to computing and microcomputers (10 hours)

- history
- present applications (for example, credit-card billing, electronic games, etc.
- applications which cannot be done
- costs
- components
- future applications
- social impact

(b) Flowcharting (10 hours)

- a logical approach to problem solving
- symbols
- sequencing
- looping
- debugging

(c) Programming in BASIC (15 hours)

- operators and order of operations
- statements

    LET
    PRINT
    GOTO
    IF...THEN
    READ...________DATA... ┐
    FOR...________NEXT... ├── Optional - as required
    INPUT
    STRINGS ┘

- functions

    INTEGER (INT)
    RANDOM (RND)
    SQUARE ROOT

-commands

    LIST
    NEW
    RUN
    SAVE
    LOAD

- additional commands depending on hardware requirements.

Course Outline – Computer Science 10 and 20

Saskatoon Board of Education

General Statement of Philosophy

Division IV computer science courses are intended to build on the skills, understanding, and attitudes developed in the Grade 7 and/or 8 computer literacy course.

The aims of Computer Science shall be:

1) to further provide the student with a realistic concept of the power, usefulness, and limitations of the computer;

2) to provide the student with an increased ability to use computers as tools for problem solving and information processing in a variety of circumstances;

3) to provide the student with more information about the effect of computers on society;

4) to provide the student with increased understanding of the historical development of computers, their makeup and operation;

5) to provide the student with a better context from which to consider possible future directions in the use of computing tools;

6) to provide the student with opportunities to work with a structured approach to problem solving using a high-level language (or languages).

The emphasis and order of these aims will vary in each course offering.

Computer Science 10

Prerequisite: Grade 9 Algebra

Topics and Percentage Time Allotments

1. Development and functioning of computer devices (12%)

- history
- computer architecture
    - computer hardware
    - components
    - computer systems
- languages
    - machine
    - assembler
    - high level
- "hands-on" experiences
- care and use of equipment

2. Applications (32%)

Use of previously prepared software

- word processing/text editing
- transaction-oriented processing
  e.g.- accounting packages
    - statistics packages
    - phone lists
- utility software
  e.g.- sort/search routines
    - "File Cabinet"
    - "VisiCalc"
- simulations, tutorials, drill and practice (i.e. CAI)

3. Societal effects: present and future (10%)

- technological breakthroughs
  e.g.- space exploration
  - bionic medicine
- computer services
  e.g.- banking services
  - information retrieval
- societal problems
  e.g.- privacy and individuality
  - computer crime
- job opportunities/further training
- employment directions

4. Problem solving (*)

- solution strategies with a structured approach

5. Programming (*)

- programming sequence
  - commands
  - syntax
  - documentation
  - debugging
  - hand-written trace
- programming style
  - top-down design
  - paragraphing/indenting/white space
  - meaningful variable names
  - built-in debugging
  - documentation (programmer's remarks)

- competencies
  - editing
  - variable manipulation/type
  - input/output commands
  - branching conditional/unconditional
  - computer-defined functions (INT, RND, SQR)
  - loops
  - screen graphics
  - elementary DOS manipulations
  - elementary string operations
  - lists (optional)

6. Consumer evaluation (6%)

- exploration of guidelines for the evaluation of products (hardware and/ or software) and services

* These components will be developed throughout the course; that is, not in single time-blocks. Their sequence will be repeated in a spiral approach and take up approximately 40 percent of class time.

Computer Science 20

Prerequisite: Algebra 10, Computer Science 10

Topics and Percentage Time Allotments

1. Problem solving (*)

   - review and extension of problem-solving techniques
   - familiarity with flowcharting and algorithmic approaches with expertise in one of these areas

2. Programming (*)

   - review of the skills from the programming section of Computer Science 10 as required (a change of language will necessitate a more thorough discussion)
   - programming style
     - flagging
   - additional competencies
     - arrays
     - searches and sorts
       - sorts to include selection and bubble
     - advanced screen graphics
     - direct memory access
       e.g.- CALLS, PEEKS
   - functions
     - built-in
     - user-defined
   - subroutines
   - subprograms
     - library of user-developed subprograms
   - DOS
     - file manipulation
     - file efficiency
     - multiple-drive applications
   - printer graphics (optional)

3. Applications (10%)

   - further use of utility programs
     e.g.- VisiCalc
   - evaluation of similar programs
     - specialized
     - utility

* These components will be developed throughout the course; that is, not in single time blocks. Their sequence will be repeated in a spiral approach and take approximately 85 percent of class time.

4. Assignments (*)

- regular assignments to enhance programming and problem-solving skills
- major project
  - development of a complete solution to a problem including oral report
  - continued monitoring of progress and clearly defined timelines are suggested

5. Societal effects: present and future (5%)

- includes job and educational opportunities

Use of Microcomputers Growing in Edmonton Public Schools

by
Peter Wright

Computer Consultant
Edmonton Public Schools

This article is reprinted from the Edmonton Public Schools Staff Bulletin, *Vol. XII, No. 33 (May 4, 1981).*

As we approach the 21st century, the computer's ubiquitous presence is increasingly pervasive. From the megabyte computers in Ottawa, which chart our life's progress from cradle to grave, to the hand-held calculator we use to check the cost of our groceries, computers will increasingly dominate all aspects of our lives.

Edmonton Public Schools have been responding to the ever-growing presence of computers. Recognizing that it is important to provide students with at least a beginning level of computer literacy, the Edmonton Public School Board initiated a pilot project involving the use of microcomputers.

The pilot project proceeded at three schools - Coronation Elementary School, Stratford Junior High School, and M.E. LaZerte Composite High School. At the elementary level, the project was designed to have students become familiar with the physical operation of a microcomputer, to assess the impact of computers on achievement, to investigate the feasibility and impact of computer-managed instruction, and to use the computer to aid the teaching process.

At the junior high school level, the project was designed so that students will understand what computers are, how they work and how they are classified, know the historical development of computers, gain awareness of current and future uses of computers, and appreciate the dynamic nature of the interaction process with computers. Students at this level also learn how to apply the method of flowcharting toward the logical solutions of problems, acquire a basic understanding of the language of programming, and transcribe a flowchart into a functional computer program.

At the senior high school level, the project encouraged teachers to investigate the diversity of applications of microcomputers, to enhance the teaching-learning process through dynamic computer-aided learning, to provide instruction in BASIC (the nearly universal language of microcomputers), to provide instruction in a second interactive language of programming (PASCAL), and to teach the use of computer graphics.

The project is currently being evaluated, and provisional examinations indicate that it has been very successful. In the project schools, both staff and student interest is high. The use of microcomputers in Edmonton Public Schools is growing at a tremendous rate. In September 1980, 19 microcomputers were in use. In March 1981, the number had grown to 43, and by September 1981, projections show that 131 microcomputers will be in use in a variety of situations.

In this rapidly expanding area, Edmonton Public Schools leads the way in providing students with access to microcomputers. We are busy preparing our students today for the exciting world of tomorrow.

Computing in Calgary Public Schools

by
Scott Brown

Senior Systems Analyst
Calgary Board of Education

Have you heard the one about the car salesman who sold a car to a caveman? He sold him a sports car. He was able to persuade the caveman that a sports car was a real necessity. He supplied, along with the car, a litre of gas and half a kilometre of good highway. The caveman really liked his car, he showed it to his friends, and he raced up and down the road. The salesman took a movie of the action and used the film to try to sell cars to other cavemen.

In the preceding story: for "caveman" read "educator"; for "car" read "microcomputer"; for "highway" read "courseware for the microcomputer"; and for "gas" read "software."

As far as Calgary Public Schools are concerned, in October 1981, we have some lovely little cars, one or two stretches of reasonable highway, but a real shortage of gas. We hear that efforts are being made to increase the roads, but the development is slow. As for the gas supply, it looks as if there is only a cup or two for each of us.

The cars we have are being guided by some very dedicated teachers in the city here. Several schools have access to mainframe computers for various programs. These schools make the link by public telephone, either to the Calgary Board of Education, the Southern Alberta Institute of Technology, or the University of Calgary. Projects at present include an extensive reading program at the elementary level, several programs to teach computer programming, some computer-assisted instruction programs, and one computer-managed learning program.

As well as these mainframe applications, there are microcomputer projects which, like Topsy, have "just growed." Some very hard-working people are leading in microcomputer applications. There are projects proceeding in elementary schools to familiarize students and staffs with the use of the computer. The same thing is happening in junior high schools with programs in the areas of options, mathematics, and industrial arts. Micros are also being used as problem-solving tools. Several high schools are currently being equipped with micros to be used in the computing science, data and word-processing programs, and some business education programs. There is a project under way to catalog and evaluate courseware. Some teachers are writing their own courseware. When you consider that it requires between 70 and 100 hours to produce one hour of good courseware, and that some of the authors are full-time classroom teachers, you can see how this task could become horrendous.

What we need for these nice little cars is a whole system of roads. We also need a lot more gas of a high quality, easily obtainable, and adapted to the Alberta (curriculum) climate. The infrastructure to support these projects needs to be in place to ensure the continued growth and expansion of the technological advances.

We cannot avoid the advance of computer technology into classrooms and the impact, unlike that of the calculator, will be felt in all areas of school curricula. To be able to judge the possible impact and the applicability of new technologies we, as teachers, need to familiarize ourselves with products such as microcomputers.

As educators:

1) we need to learn how to drive, and as we learn we should make certain we have lots of roads and lots of gas. We should know where we want to go, andwe should then go out and buy the right car to get there.

2) we must make sure that we are in a position to evaluate these technological advances and to implement those parts we feel will benefit our students.

3) we cannot ignore what is happening!

4) we should get ready to drive cautiously!

Instructional Use of Microcomputers in Red Deer Schools

by

R.W. Pawloft

Coordinator of Instruction
Red Deer Public School District #104

With substantial financial assistance from the local "Alberta 75th Anniversary" committee, the Red Deer Public School District's microcomputer projects now involve 36 APPLEs, seven PETs, four TRS-80s, and associated peripherals.

From the outset, the purchase of hardware, software, courseware, the maintenance of hardware, and the planning for inservice sessions as well as subsequent support for teachers have been centrally coordinated. Due to the initially low level of expertise with computers and a lack of knowledge regarding instructional computing, both locally and provincially, the Red Deer Public School system decided to become an institutional member of the Minnesota Educational Computing Consortium, a decision which has not been regretted.

All of the Red Deer micros are totally devoted to instructional computing. The new DEC 2020 is designed to meet the school system's administrative needs although Computing Science 30 students will have some access to the mainframe beginning September 1982.

The following is a brief indication of the distribution and the instructional use of the Red Deer microcomputers.

Elementary Schools

Two APPLEs, (48k, dual disk drives, printer) mounted on mobile carts, are used to support regular instruction in mathematics. One of these two APPLEs is also used with resource room students to remediate student weaknesses in mathematics and language arts. A third APPLE system is used exclusively with special education students.

Junior High Schools

Effective this fall, each school has four APPLEs available for the duration of the school year. The primary purpose is to teach a system-wide computer literacy course to all students in the Grade 8 and 9 mathematics classes and to meet some of the "NCTM Recommendations for the 1980s." All junior high teachers will also have access to a sophisticated "Class Records" program. This program was written by a local teacher and is designed to manage class lists, student biographical data, attendance, and marks. The four TRS-80s are used by one junior high school for remedial math and language arts.

Senior High Schools

A total of 11 APPLEs and seven PETs are located in the system's only high school. Last year, a microcomputer lab was established containing ten APPLEs and five PETs in order to teach Computing Science 30, Data Processing 20, the "Challenge Program" for gifted Grade 4 and 5 students, and in order to support instruction in mathematics and science (although currently on a limited basis). This facility is also heavily used for after-school teacher inservice, a microcomputer course sponsored by the University of Alberta, and evening courses for the public. The remaining two PETs are currently used for word processing by the business-education department.

For the 1981-82 school year, the intent is basically to continue working in areas described above in order to gain badly needed experience in the instructional use of microcomputers. This experience, together with some leadership and direction from Alberta Education, is essential before considering expansion or redirection of the instructional use of microcomputers in Red Deer classrooms.

Computer Education In Lethbridge School District #51

by
Hank Boer

Math/Science Coordinator
Lethbridge School District #51

Computer education has been part of the Lethbridge education system for many years. The first computer facility used was the Hewlett-Packard 2000 at the University of Lethbridge. Schools used a teletype terminal interfaced with the University of Lethbridge computer via telephone lines. The computer was used for computer-assisted instruction (elementary and junior high) and computer programming (junior high). The software was developed by Hewlett-Packard.

In 1980, the school district converted to microcomputers. At present there are 18 APPLE microcomputers and one Northstar. The computers are being used by students at all grade levels for computer-assisted instruction, computer literacy, and computer programming.

In the high school program, computers are being used for computing Science 30. This course is being offered at both of our high schools and has received a very favorable response from students, teachers, and administrators. Computer-assisted instruction will be made available in the coming year in mathematics and science.

All the junior high schools offer computer programming as an option to the regular program. As yet, computer-assisted instruction has not been introduced to the regular program because of the lack of available hardware.

At the elementary level, computer literacy and computer-assisted instruction are emphasized. Three APPLE computers are moved between schools on a monthly basis. These machines are used for introducing teachers to computer education, and for developing computer literacy for teachers. Two APPLE computers at Fleetwood-Bawden School are used for computer-assisted instruction in elementary mathematics. The ECR Math Drill program, developed at the University of Alberta, is being used for students experiencing difficulty in mathematics.

The primary objective, at all levels, is to make as many teachers computer literate as possible. As teacher computer literacy increases, the integration and expansion of computer education into the regular program will increase. In the near future, teachers will be involved in the development of computer-literacy packages and computer-assisted instruction that is specific to the needs of the school district.

ISSN 0711-2521

PRINTED AT
BARNETT HOUSE