COMPARING EVALUATIVE MODELS FOR COMPUTER ASSISTED INSTRUCTION DELIVERED BY MICROCOMPUTER IN B.C. ELEMENTARY SCHOOLS

by

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ABSTRACT

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A study of the implementation of computer assisted instruction (CAI) delivered with microcomputers was undertaken, with special reference to approaches used to evaluate the lessons or courseware run on the microcomputer in elementary schools of B.C.

A model for identifying and describing the important features of courseware had been developed by the JEM research team, a group responsible for co-ordinating the first large scale introduction of microcomputers into the British Columbia school system. Since the teachers' requirements for courseware evaluation were not precisely known, a sample of 12 elementary school teachers experienced in the use of microcomputers was surveyed to assess their needs, and to determine to what extent the present system was meeting them.

It was hypothesized that if evaluations developed from the JEM evaluation model were meeting the informational needs of elementary classroom teachers, then there would be no difference between the evaluation information derived from the model and evaluation information considered important by teachers.

It was discovered that not all the information that teachers considered important was being provided by the JEM evaluation model, although it did serve several important functions. The teachers

found the JEM courseware evaluations to be helpful in the selection of suitable courseware, and the courseware most highly recommended by the JEM analysts was also the courseware most used by the teachers.

An eclectic evaluation model was developed to extend and refine the JEM model. Teachers' judgments were incorporated into the evaluation process to provide a more complete and balanced evaluation product.

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I wish to acknowledge the contribution of Denise Forman of JEM Research who was instrumental in getting me started on the topic of evaluation of CAI courseware, and who assisted in keeping me aware of the rapid developments occuring in the field. I am also indebted to the teachers who participated in the interview and questionnaire; their cooperation was an important factor in this study, and greatly appreciated.

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CHAPTER I

Overview

This chapter is divided into four sections: (1) the "Introduction" deals with some of the general implications that the arrival of the microcomputer holds for education; (2) the "Historical Background" describes the Instructional Uses of Microcomputers Project, an effort undertaken by the B.C. Ministry of Education to determine the feasibility and desirability of a widespread introduction of microcomputers into the provinces school system; (3) the section on "Personal Involvement" deals with the author's involvement in an aspect of that project that ultimately gave rise to the purpose of this study; and (4) the "Purpose" is discussed in the closing section.

Introduction

Some remarkable advances in microelectronics has brought the computer within reach of many educators in North America. The microcomputer has arrived on our doorstep accompanied with claims that its impact could be as dramatic and far reaching as that of the printing press, or the development of writing (Kay, 1977). Whether or not any substance exists in these claims remains to be seen, but the infiltration of microcomputers into our schools is already occurring.

A number of definitions of microcomputer have been offered. Tinker and Stringer (1978) give one of the simplest: it is an inexpensive, small computer. Functionally, the difference between the microcomputer and a standard computer is in the smaller amount of information which can be addressed and the slower speed at which it can be processed by the microcomputer. They note that for many applications, there is no discernable loss in effectiveness with the microcomputer due to the scaling down in size. Gleason (1980) offers a more technical definition by stating that they are stand alone devices with binary data processing capability up to 64 thousand bytes (64K). Most systems are capable of supporting peripherals such as disk drives, television monitors, or printers. Perhaps the best defining characteristic is price; microcomputers are available for as little as 200 to 400 dollars, up to as much as 5,000 to 6,000 dollars.

Computer assisted instruction (CAI) is instruction administered by computer. It refers to teaching and learning which occurs as the result of interactions between teachers, students, course materials and a computer. It is really a modified form of programmed instruction, but it differs in requiring more attention to methods and student characteristics. The computer can change content and mode of instruction, and vary its interactions according to the student response on a more complex level and more rapidly than other programmed learning materials. CAI is capable of simulating more teaching behaviours than earlier teaching machines (Huntington, 1979). The materials which

package and deliver CAI are often referred to as courseware. Such instruction can be successfully delivered by the microcomputer via tapes or diskettes.

With any innovation comes change. Usually linked to significant and dramatic change is confusion, disruption, and disorder. Yet education must be open to change to remain relevant to our students and our society. Educators need to recognize and identify those innovations which have potential teaching applications for progress to occur. Innovations which hold promise of advancing the educational enterprise must be given a chance to prove their worth. Our task as educators is to try and bring about change in our schools in as orderly and productive manner as possible. Great savings in resources (time, effort, and money) can be realized when changes are effectively implemented. Efficient and effective implementation requires careful planning, and an understanding of the general problems associated with the implementation of any innovation. In addition, we must be alert to any special difficulties which may be unique to the innovation in question.

With the arrival of microcomputers has come some urgent and pressing concerns. What are the appropriate uses for this technology in the educational process? How can the microcomputer be effectively implemented into our schools? What benefits can be realized by our students if this technology is introduced now? These are some of the big questions. But as one of the most experienced educators in the field (Bork, 1980) points out, we are only beginning in our task of

learning how to use the computer in education. Indications are that years of effort based on trial and error approaches may be needed before firm answers to such questions become available.

In B.C., an important start has been made in the effort to address some of these major concerns. The B.C. Ministry of Education has provided microcomputers to a substantial number of schools throughout the province, and has conducted a pilot study to gather information on which to base future decisions. Soon other regions will be faced with a decision as to whether microcomputers should be widely adopted within their school systems. What can be learned from the B.C. experiment that would be useful and relevant to other educators? What were the major problems confronted?

Historical Background

The historical background for the Instructional Uses of Microcomputers Project is documented in a series of discussion papers produced by Joint Educational Management Projects (JEM), a private, non-profit research group which works under contract on behalf of the B.C. Ministry of Education, and in a summary article prepared by Forman (Note 1), a member of the JEM research team. The synopsis that follows is based on those sources, and on a presentation given by S. Crawford (Note 2), also from JEM at the Forum For Teachers Currently Using Microcomputers In The Classroom, conducted at the University of British Columbia, July 8 and 9, 1981.

Ministerial involvement in microcomputers was initiated in response to requests from a number of educators who wanted to see the level of computer literacy raised in the province, and who wanted to employ computer technology in ways that would enhance education. As B.C. had not made any heavy financial commitments to large computers and timesharing systems, the Ministry was in a position to consider alternatives. Surveys to establish what had been done elsewhere led to the realization that computer assisted instruction was not only a realistic goal, but economically feasible if the delivery system was the microcomputer.

> . . . supporters of the use of microcomputers in education pointed to the outstanding success of MECC, the Minnesota Educational Computing Consortium.
>
> . . . a visit to Minnesota by representatives from the Ministry, JEM, and the school system resulted in a decision to introduce microcomputer technology into the schools of B.C. along a model developed by MECC who extended their full cooperation and encouragement and offered to B.C. the benefits of their experience.
>
> (Forman, Note 1)

The delegation was impressed by the MECC effort, and could see clear advantages in introducing the microcomputer in B.C. in a well coordinated fashion. In other states, a lack of coordination resulted in different schools running on different systems, preventing them from enjoying the advantages of sharing courseware (courseware is not readily transferable between various makes of microcomputers) and of obtaining discounts through bulk purchasing.

The JEM research team submitted a proposal to the Ministry for the development of a pilot project in B.C. which would adapt the MECC approach to our needs. The purpose of the project was to make available to selected schools of B.C. the best in microcomputer hardware in a manner consistent with the needs of the Ministry and the needs of teachers. A primary emphasis was to be placed on the integration of this technology into the provincial curriculum, the evaluation of the usefulness of it in an educational setting, and the gathering of information on the basis of which the Ministry could establish a policy for the extensive introduction of microcomputers into the schools of B.C.

The selection of a brand of microcomputer was the first task faced by the JEM researchers. Before the selection, they drew up a list of requirements, and then a number of different makes were evaluated. Included in the evaluation was the Apple II, the Commodore PET, the Radio Shack TRS-80, the Atari, and the Intecolor. The Apple II Plus with 48K of memory and a disc drive was selected by JEM as the most suitable system for a number of reasons: it had colour capabilities, both high and low resolution graphics, light weight and easy portability, good durability, firmware available for higher level language other than BASIC, and the ability to accept a wide range of peripheral devices such as card readers, graphics tablets etc. as well as excellent manuals for self instruction. A key factor in the selection process was the availability of educational courseware. As MECC had also been using the Apple II, an extensive library of educational programs could be made available, along with the documentation required

to enable teachers to use the materials effectively.

The task of selecting the schools to participate in the pilot project was carried out by the Ministry. The school districts interested in taking part were asked to submit proposals as to how they might utilize a specific number of microcomputers. Fifty of the province's 75 school districts submitted proposals, and 12 districts were chosen as pilot sites. One hundred Apple II microcomputers were distributed among the 50 pilot schools. The criteria on which the selection was made included the uses proposed, the physical setting and the context of the application (i.e. classroom, laboratory, resource centre, library), the geographical location (urban or rural), and the level (elementary, junior secondary, or senior secondary). An effort was made by the selection committee to achieve a distribution of the sites throughout the province, and throughout the various levels of the school system. The task of acquiring and distributing the microcomputers to the various schools was made the responsibility of the B.C. Systems Corporation and was carried out in August, 1980.

In the phases of the project which followed, JEM played a complex role in facilitating the pilot schools with the implementation process. One week workshops were held at the University of Victoria and the University of B.C. during the summer prior to the introduction of the microcomputers in the schools so as to familiarize the pilot participants with the Apple II. In-service training directed by the universities was continued throughout the year, providing one day, evening, and weekend workshops for both the pilot and non-pilot school districts.

Other support services were provided. A 400-page Reference Manual was published to aid teachers in setting up the equipment, selecting and evaluating courseware, and in developing their own programs. A monthly publication called Microscope served as a vehicle for exchange of information, keeping teachers informed of the progress of the pilot project and new developments in the microcomputer field. Members of the research team also visited the pilot sites to monitor activities, and provide information and assistance. An arrangement was made with MECC to share all their available courseware and documentation with the pilot schools. Courseware was continuously evaluated and the results were published in Microscope; new materials were demonstrated during visits to the pilot schools.

Another phase of the JEM involvement was the support of courseware development efforts of teachers. Teachers interested in developing a program, on acceptance of their proposal, received up to 500 dollars for a completed project. Most proposals were accepted, although some were rejected on the grounds that acceptable courseware of the type proposed was already available.

To facilitate integration of available courseware into the curriculum, about 1,000 educational programs were assigned by JEM researchers to the appropriate subject area and grade level, and listed in a computerized index using the Apple II. Also, JEM working in conjunction with the Curriculum Development Branch designed an evaluation instrument which permits evaluation of microcomputer materials in terms of their educational value, relevance to the B.C. curriculum, and the

effective use of the microcomputer. The efforts to date have provided the Curriculum Development Branch with a "curriculum map" for microcomputer courseware. A respectable mass of information now exists regarding areas where courseware is available and where there are gaps. Educational publishers and courseware developers have been made aware of these gaps, and so effort can be directed to areas where a need exists. To aid teachers in the development of such courseware, a Standards Guide was prepared.

A formative evaluation of the pilot study carried out at the half way point of the project revealed that educators and students involved were highly enthusiastic about the use of microcomputers. However, the educators were realistic in recognizing the limitations that presently exist, and a number of critical concerns were identified.

> . . . The single most critical issue in the use of microcomputers in the schools of B.C. was the acquisition, development, and sharing of quality CAI materials relevant to the B.C. curriculum.
>
> (Forman, Note 1)

Evaluation and description of commercially available courseware with reference to its quality and relevance to the B.C. curriculum was seen as a priority requirement. The documentation of areas where courseware correlates with specific areas and grade levels and the development of a delivery system for making courseware available were considered among the important aspects of this issue.

The pilot project was completed at the close of the school year at the end of June, 1981. The summative evaluation of the project was

carried out by the Educational Research Institute of B.C. and the results are to be published in the near future. A number of interesting findings revealed by this evaluation were summarized by S. Crawford (Note 2). The most commonly used school location for the microcomputer was the regular classroom (55%) followed by the laboratory (21%). The most frequent purpose for its use was to augment instruction (64%) although provision of instruction not normally available (30%) accounted for a considerable portion of its use. The majority of teachers (60%) were very interested in the educational use of computers, though a small minority existed which were very uninterested (2.6%). Student attitudes were also favourable, with 50% stating that they were very enthusiastic, 38% enthusiastic, but 8% were discovered to be unenthusiastic. In the view of the teachers involved, the pilot project was viewed as successful in meeting its goals (61% satisfied, 19% very satisfied).

Personal Involvement

For a short period of time, the author was involved in assisting JEM researchers (on a part time basis) in carrying out courseware evaluations and descriptions, as experienced teachers familiar with the microcomputer were needed to help carry out that task. A procedure had already been developed by the JEM team to guide evaluators in this process. A list of design features were provided for use as a checklist (see Appendix F). Evaluators were instructed to become thoroughly familiar with the program by running it while playing the role of the

student. At least one run was required modelling the response of a capable student; another run would be required to model the responses of an incapable student in order to judge the degree of individualization inherent in the program. The evaluator would then examine the supporting documentation. For some of the more complex programs, the documentation would have to be consulted before the student roles could be modelled, and many more trial runs would be required.

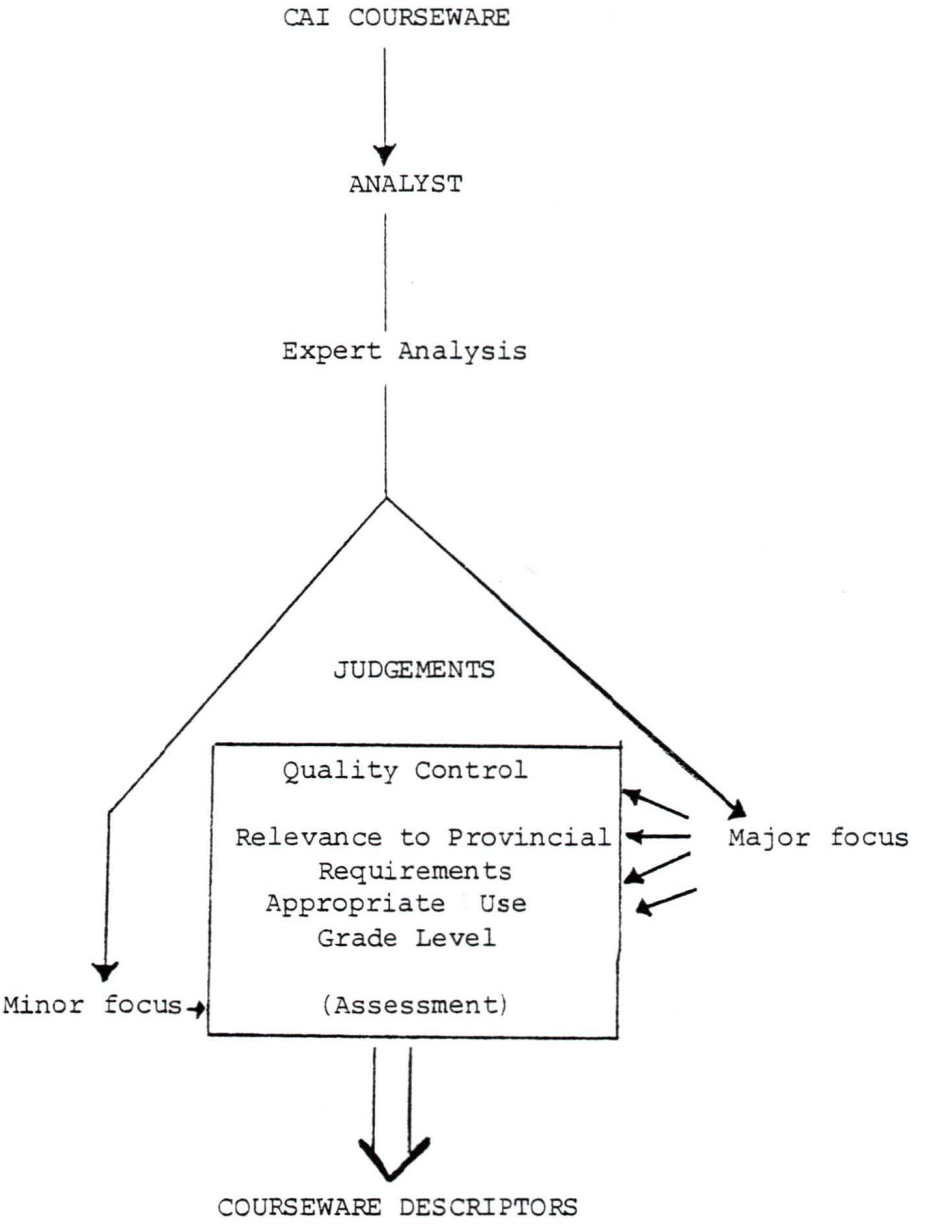
In general, four major concerns were addressed in the reviews: quality control, grade level suitability, provincial requirements, and appropriateness as basic, supplemental, enrichment or drill material. After becoming familiar with the program, a description of it would be written, the subject area and appropriate grade level assigned, and a comment given regarding the reviewers general impressions of the program. Any distinctive features of the program (good or bad) would generally be noted. The basic model is graphically illustrated in Figure 1.

Although a considerable amount of courseware had been available for evaluation, the author's part time position could not be supported after some budget cuts forced a reduction in JEM staff. The evaluation effort did not end, but was carried out by permanent JEM staff members who were redirected from other assignments to complete the task.

Although the JEM evaluation approach seemed to be adequate for the immediate purposes of a short term pilot project, it was realized that it could not be viewed as a fully comprehensive evaluation system for a long term implementation of courseware. A major concern was the

Figure 1

The JEM Model for Evaluation of CAI Courseware



lack of user data; little information was available based on classroom trials of the materials being evaluated. A number of questions required addressing before a more comprehensive plan could be reasonably formulated. What CAI programs were teachers finding most useful, and what were their characteristics? To what extent were our present evaluations meeting the needs of the teachers? What did teachers consider to be the most important components of good courseware? Answers to such questions would have provided us with useful guidance in our evaluation effort. The collection of data to resolve such questions could not be undertaken by the team without incurring additional expense or a substantial redirection of effort. As the problem appeared to be worth pursuing, it became the focus of this study.

The Purpose

It was the original intention of the JEM research team to base courseware evaluations on data developed through classroom trials. However, since CAI courseware had to be provided to pilot schools at the beginning of the implementation in September, 1980, no user data was available. Not enough data was obtained during the course of the pilot study to enable the original intentions of the JEM team to be carried out. How much more effective would the Courseware Descriptors have been if teacher use data had been included? Would the extra expense and effort required to obtain the teacher input have been justified?

The main purpose of this study was to test the adequacy of the JEM evaluation model used to produce the Courseware Descriptors. This was accomplished by comparing and rating statements derived from analysts applying the JEM evaluation model with statements derived from teachers who have experienced the use of specific CAI programs with students. It was hypothesized that if the evaluations developed from the JEM model are meeting the needs of classroom teachers for information, then there will be no difference between the statements provided in the Courseware Descriptors and the statements considered important by the classroom teachers.

H_o: *There is no difference between evaluation statements derived from analysts applying the JEM evaluation model and evaluation statements considered important by teachers.*

The information in this instance is data which can be used as a basis for making informed decisions and choices in the use of CAI courseware, and communicates to teachers in terms which they find meaningful. Models represent aspects of theory, and interpret them in ways which can be used to guide practical decisions and actions.

> . . . Generally speaking, models are miniature representations that summarize data and/or phenomena and thus act as an aid to comprehension.
>
> . . . the term "model" sometimes is used as a synonym for "theory," it more properly connotates the representation of only a portion of a theory. One of the main functions of models is to aid in theory building.
>
> (Zais, 1976)

Zais states that models are useful in educational theory building, since they can be used as tools in which to think about curriculum and the formation of new theoretical constructs. He notes that models aid theory building by suggesting questions that need to be asked of data, and by providing clues to possible answers. He states that this is particularly true of graphic models, which enable planners to visualize curricular components, their relationships and processes of development and implementation:

> . . . graphic models are usually drawings or diagrams of some kind that attempt by visual means to describe the components of the thing being modeled and to explain the relationships among its parts.

The JEM model has been introduced conceptually as well as graphically in the previous section on Personal Involvement. No widely accepted model for the evaluation of educational materials presently exists; evaluators must develop their own approaches after assessing the evaluation requirements of the individuals they wish to assist. The sudden development of microcomputer technology created a difficult situation, since JEM was commissioned to evaluate CAI courseware before there was any significant number of teachers using microcomputer technology in B.C. elementary schools. The JEM model for evaluation of CAI courseware was therefore a pioneering attempt to guide analysts in their efforts to provide useful data for teachers using these materials. Its strengths and weaknesses have yet to be critically examined.

The classroom teachers involved in the study were selected on the basis of the following criteria: (1) at least five year's teaching experience; and (2) at least one year's experience in the use of CAI with microcomputers and students ranging from grade three to seven. The analysts were educators with teaching experience, and were thoroughly familiar with the use of the microcomputer and a wide range of courseware.

It has become clear from the outcome of the pilot study that we urgently need effective instructional materials to achieve full realization of the capabilities of the microcomputers in our classrooms. An effective evaluation system can help guide the identification, accumulation, and development of the required courseware.

> . . . neither a theoretical basis nor accumulated experience exists for determining the minimum evaluation requirements to be met in order to certify a new program for widespread usage in an educational system. Each system should determine standards on the basis of local circumstances. A system in which a great variety of programs are available may impose higher evaluation requirements for curriculum than might emerging educational systems in which few programs are available.
>
> (Lewy, 1977)

Since educational innovation is only justified to the extent that evidence can be obtained establishing that benefits actually result, an appropriate form of evaluation must accompany the innovation. As Lewy implies, an emerging system will require a different evaluation emphasis than a system more developed. If Lewy's view of evaluation is realistic, we must frequently re-examine the evaluation system

being used to determine if it is meeting the requirements set for it.

The present pattern of CAI courseware use in B.C. schools, where programs usually augment rather than replace traditional instruction, makes it difficult to compare CAI with traditional instruction. For example, students requiring extra drill on a specific skill may use a program designed specifically to develop that skill area. The majority of the class may not be using that program. Also, most of the programs available are fairly short. Any study on student achievement or attitudes would result in findings too specific to be generalizable, unless they were carried out on a very large scale. Such studies would require considerable resources and skillful management to be successfully carried out.

One of the most important findings to come out of the B.C. pilot project was the need for identifying, developing, and sharing of quality CAI courseware. Yet this was not an area overlooked by the planners of the project. That its importance had been anticipated is supported by the existence of the JEM Reference Manual (1980) which is largely devoted to cataloguing, indexing, and describing available courseware. Such a situation leads one to suspect that the process of identifying and evaluating courseware is more complex and important than previously realized, and suggests that our present approach may need revising.

A special concern of this study was to identify the characteristics of CAI courseware which may be most effectively implemented into the

B.C. Elementary Schools. To achieve this goal, it was necessary to focus on some basic questions. What are the most important components of good quality courseware? What are the limitations of the courseware presently available? Reliable answers to such questions will provide guidance for evaluators since they will have a clearer idea of what should be assessed.

The procedures for obtaining data relevant to the purposes of this study included: (1) analysis of courseware evaluation questionnaires completed by teachers; (2) analysis of courseware descriptors prepared by the JEM researchers; and (3) analysis of interviews and questionnaires completed by a sample of 12 elementary school teachers experienced in using CAI courseware.

Justification for an approach which focusses on teacher input comes from such curriculum workers as Danley and Wahlstrom (1980) who have come to the realization that the richest source of information on student progress and achievement is the classroom teacher's observations of day-to-day development of their students. They consider these observations to be the most reliable and valid measures available for a number of reasons: (1) they are continuous over an extended period of time; (2) the teacher is able to observe all dimensions of student growth, even subtle nuances that indicate confusion, frustration, or confidence; and (3) the responses and reactions of students occur in a natural state, without the tension and anxiety that often influence test results.

A small population of B.C. teachers familiar with the use of the microcomputer and a range of CAI programs is now available as a resource to the reseacher, and should be capable of providing data useful in resolving the questions posed. Acceptable and reliable answers to these questions may provide evaluators with a better basis for dealing with and developing more effective models for evaluation of CAI materials.

CHAPTER II

REVIEW OF RELATED LITERATURE

Overview

The "Introduction" notes one of the fundamental concerns of educators with regard to microcomputers in education, a concern which is examined from different perspectives in the sections which follow. In the "Current Trends in the Use of CIA" section, studies are reviewed which have attempted to assess the benefits of computer use in education. In the "Problems of Implementing CAI," the factors relevant to effective introduction and adoption of the microcomputer are reviewed. The "Evaluation of CAI" considers the importance of evaluation, and outlines a number of evaluation plans which are currently in use for the evaluation of courseware.

Introduction

The computer has already had an enormous impact on our society; its influence is felt in diverse areas of modern life ranging from novel games of entertainment to sophisticated guidance systems enabling man to explore distant regions of our solar system. The microcomputer brings with its reductions in size and cost little reduction in general computing capabilities. A wide open field for new applications has

presented itself.

Yet, as has been suggested by Kay (1977), the impact of this new technology on education may well be subtle. We should not expect the microcomputer to foster a revolution in education simply because it has the potential to do so. Telephone, television, and film have stimulated similar predictions which have not come to pass. Can the microcomputer play an important role in the educational experience of students in B.C. schools? A review of the literature reveals that this question is complex, and suggests that it may be some time before a ready answer will exist.

A. Current Trends in the Use of CAI

Numerous studies have been carried out on the use of computers in schools. An extensive CAI effort in Ontario undertaken by Gershman and Sakamoto (1981) presented a number of interesting findings. The achievement gains of the CAI group were found to be significantly greater than those of the control, students' attitudes towards the subject taught improved, and they became familiar with computers. Also, the teachers showed a favourable response, and considered the effectiveness of their teaching to have improved. All the teachers in the study and 96% of the students expressed the desire to continue using the computer for the course.

In one survey of CAI studies, Magidson (1978) found CAI at least as effective as conventional approaches in 55% of the studies, and more effective in 45%. In another survey, Gleason (1981) states the

research pretty well establishes that CAI can be used to assist learners effectively with a 20% to 40% time saving compared with conventional approaches, that retention is as good as with conventional sources, and that students react very positively to good computer programs. It would appear from these studies that important educational benefits are possible with well planned and implemented CAI programs.

It should also be noted that research shows the microcomputer to be a general purpose information processing machine which has application in many other educational settings besides CAI. Watts (1981) describes a dozen uses for the computer in education ranging from administration to computer literacy. Even in the confines of a single classroom, the microcomputer can be useful in a multiple of applications. Tinker and Stringer (1978) found the microcomputer to be useful in diverse ways in their Physics teaching. Uses included data analysis, graphing, monitoring of experiments, operation as a signal generator and waveform synthesizer, as well as the normal classroom administrative purposes such as recording marks and attendance. Clearly, the microcomputer can be viewed from a broader perspective than CAI when considering the total educational context. However, the results of the B.C. experience show that the use of CAI programs accounted for the most significant portion of microcomputer use in schools (Forman, Note 1).

Gerhold (1980) considers the microcomputer to be ideally suited to the delivery of CAI, but notes that a major problem area exists due to the severe shortage of quality courseware. Chambers and Sprecher (1980)

state that up until now, high costs accounted to a significant extent for the lack of use of CAI in learning situations, especially at the elementary and secondary levels. Now that hardware costs have diminished rapidly, we have reached the point where development of CAI courseware appears to be the single cost factor of concern. One hundred hours of preparation time for the production of one hour of CAI courseware is now accepted as a rule of thumb. Materials designed to run on microcomputers have been reported to have the lowest costs. CAI programs running on microcomputers at the Highland School District in Seattle and in Philadelphia schools show some of the lowest costs achieved. In their recommendations, Chambers and Sprecher report the need for quality courseware to be recognized and widely distributed to enable costs to be reduced; effective evaluation and sharing of quality courseware should therefore be recognized as a priority. Brown (1975) predicts that the costs of writing, evaluating, and updating computer courseware will be the greatest system expense, and also shares the view that good courseware must be made available to a large body of users.

Some fears have been expressed that the field of microcomputer technology is advancing so rapidly, present systems and courses may soon become obsolete. Gleason (1981) predicts that such advances as are occurring now are likely to be continuous. Since the systems available now are capable of improving educational programs, he feels there is little to justify waiting for further refinements in hardware.

B. Problems of Implementing CAI

> . . . There is a real danger that microcomputers will be purchased by schools and shortly, neglected to a cupboard for most of the time.
>
> (Halworth and Brebner, 1980)

The literature discloses that a serious concern exists about whether microcomputers can be effectively implemented in general educational settings. Implementation deals with the actual use or putting into practice of an innovation. As Fullen (1979) notes, the process is much more complex in reality because implementation is multi-dimensional. Only recently have researchers gone beyond the appearance of an innovation to look at what is actually happening as teachers in schools begin using a particular change. Implementation studies often show a major discrepancy between what the innovation is supposed to be and what is actually happening. Such studies are important since they can provide valuable insights into how changes can be introduced into schools in an orderly and effective manner.

Rutherford (1979) maintains that the more complex an educational program, the more difficult it is to implement, and the longer it takes for teachers to reach high levels of usage. His experience indicates that orderly and productive change can be introduced into schools, but that this is not the usual pattern. In the early stages, one must expect that much time will be spent by teachers using the program at a mechanical level, with little attention given to the impact of the program on the learners. Adoption of the new program is not an event that occurs at a

single point in time, but over an extended period. Change efforts must not focus entirely on the program per se, but on individual teachers--their needs and requirements to enable them to become effective users.

One important factor is that of teacher resistance. House (1974) in his analysis of the fate of a typical educational innovation with computers, concluded that the imposition of any externally developed innovation was almost certain to stimulate teacher resistance. Unless that resistance can be overcome, it will eventually doom the innovation no matter how eloquent, powerful, or well-funded the advocates of the innovation may be. House states that the best way to achieve long-range acceptance and success of an innovation is to involve teachers in the creation of it.

Gerhold (1980) agrees with House's conclusions, and suggests that one way to achieve teacher acceptance of CAI delivered by the micro-computer is to involve the greatest number of teachers in the creation, or revision and editing of CAI courseware. He stresses that care must be taken not to stimulate teacher resistance by raising expectations to too high a level. Claims for CAI in the future must be so conservative that they are sure to be realized, particularly in areas of costs, courseware availability and results to be achieved.

Another concern is teacher preparation. Milner (198I) claims that teachers do not know how to make effective use of computers in the classroom because of the lack of training opportunities. The computer requires new ways of thinking and new approaches to teaching. New courses

must be provided along with other support to enable teachers to overcome their initial resistance to change.

Gerhold's (1980) work on teacher produced CAI deserves mention because it shows a promising approach towards overcoming teacher resistance and helping improve teacher preparation. By operating a summer workshop at Western Washington University, he successfully trains teachers in the writing of CAI courseware. Practically all the participants produce an acceptable unit of courseware for use in their classroom by the conclusion of the course. In this process, they develop many of the skills needed for the effective use of the micro-computer in the classroom. As many of the graduates continue producing courseware which can be made available to other schools, progress is being made at increasing the amount of effective courseware available to the state school system.

Another difficulty stems from the fact that the field of computer education is in its infancy, and the most productive uses and applications for education may not yet be known. Bork (1980) maintains that we are only beginning in our task of learning how to use the computer in education, and the process of learning to use it effectively will require long years of trial and error. Lower (1980) has found the computer to be similar in many respects to other learning tools, in that its effectiveness is highly dependent on the role it is assigned to play in the course. As with other audio-tutorial methods, the computer must be integrated into the course in a comprehensive way, and only to the extent it is needed to accomplish the purpose of the course.

Such examples serve to illustrate that the microcomputer technology carries with it many complexities which can be counted on to create implementation difficulties for those whose planning fails to take them into account.

C. Evaluation of CAI

Some evaluation literature makes specific reference to the importance of evaluation for effective implementation of CAI, and also to the difficulties encountered when one attempts to carry out evaluation studies.

Magidson (1978) explains that most CAI is currently being used to supplement and complement traditional instruction, not replace it. This situation makes it difficult to compare CAI and traditional instruction since the emphasis of each component is often adjusted to the needs of the individual student. Gerhold (1980) states that only a fraction of what we hope to teach can be evaluated by comparative testing. He notes that it is difficult to defend general conclusions about CAI based on specific versions of courses tested with specific groups of students in specific environments. To have much validity, such testing has to be carried out on a large scale--a costly and somewhat formidable task. Morgan (1978) adds that comparisons made between CAI and conventional instruction must be carried out over a standard period of time before they can be very meaningful, since CAI often results in faster and more efficient learning, rather than more effective learning (as indicated by higher achievement scores).

Gerhold (1980) believes the most useful method for evaluating CAI materials is to ask the teachers using them. He claims a good teacher is sensitive to students' progress and problems in ways no test can ever replicate. He regards the tendency to downgrade informal evaluation by teachers and the increasing reliance on standardized tests a disastrous trend in education.

Evaluation is known to have a powerful influence on learning. Tyler (1949) noted that the New York Regent's examinations had more effect on what was taught in New York State than the course of study outlines. Not only were teachers influenced in their emphasis on what was taught, students were influenced in what they studied by the particular evaluation procedure in use. Unless the evaluation procedure closely parallels the educational objectives of the curriculum, the evaluation procedure may become the focus of the students' and teachers' attention, rather than the curriculum objectives set up.

When it comes to evaluation of teaching materials, we can also expect evaluation to have a strong influence on the types of materials produced. As with evaluation of students' learning, the evaluation procedure should closely parallel the educational context in which it is used. If it is important to know the classroom effectiveness of the instructional materials, then it would seem essential that assessments be based on actual use of the materials in typical classroom settings. A number of evaluation strategies can be examined in the light of this rationale.

Since high quality courseware is expensive and time consuming to produce, strategies have been developed for evaluating courseware to enable quality materials to be identified. Some representative strategies are described.

1. The Illinois Plan

In the rationale to the University of Illinois strategy (Note 3), it is stated that computerized materials require evaluation perhaps even more so than text materials, since computer lessons must frequently function independently of teacher intervention. Also, inappropriate sections of text can be quickly altered, augmented or eliminated--an option not so readily carried out with computerized learning materials. It is also noted that computerized materials are much more difficult to evaluate and describe since an interaction takes place which should vary according to the ability of the student. This feature adds a level of complexity not found in most other learning materials.

> . . . This situation almost demands that materials be experienced, at least by the teacher playing the role of student, if not by the teacher witnessing their use by students.
>
> . . . It is almost impossible for teachers accurately to assess the value of text materials without seeing them in action. Often, teachers select and purchase textbooks, sometimes even after lengthy examination, only to decide a year later that it is not as they had expected in the classroom. Since there is little else one can do to "test" classroom materials, text publishers cooperate in classroom trials of their products.

However, after recognizing the importance of teachers seeing text materials in action, nowhere is it stated that it would be essential to conduct courseware evaluations in the same manner. Instead, mention is made that it is usually desirable to observe students interacting with the computer. The document projects the view that an experienced teacher is capable of determining the effectiveness of courseware by carrying out a systematic analysis of the program with the aid of a courseware evaluation worksheet. This evaluation tool attempts to extract an accurate description of the contents of the program, as well as a rating of 35 factors such as speed of response, clarity of vocabulary, suitable length, etc. The instrument is ten pages in length of which two pages deal with ratings and slightly more than one page deals with data that could be derived by direct observation of students.

2. The Conduit Plan

Conduit, an agency supported by the National Science Foundation, also conducts reviews and evaluations of courseware and has evolved its present system over a number of years. Peters and Johnson (1978) state that reviews are conducted by "peers" (other courseware developers, one would have to assume) focusing on correctness of lesson content and effectiveness of approach. Reviewers are guided by a four page rating form developed to provide a consistent means of collecting evaluations of CAI packages. They state the category most predictive of the overall rating is the section judging support of the overall

teaching process. Factors such as ease of integration with course procedures, potential for improving the instructor's ability to communicate methods and techniques, and the potential for teaching how to intepret and apply results, and overall instructional quality are rated in that section of the evaluation instrument. However, those who order Conduit materials place subject matter first, followed by instructional quality in order of importance in their decision making. They also report that an analysis of judgements of reviewers who were users of the materials showed no significant difference in evaluations when compared with reviewers who were non-users. According to Gleason, the review of a typical program by Conduit requires approximately 40 hours of analyst time.

3. The MECC Plan

MECC has recently begun publication of courseware reviews. Though the evaluation instruments used for production of their reviews were not available, analysis of a review establishes that their strategy is firmly based on classroom trial of the courseware, and adheres to a clear and well organized format.

A typical review is one page long, and contains three main sections. The first section begins by identifying the program, producers, support materials, and cost followed by a brief account of what the program is designed to do. The second section provides a critique of the program based on classroom trial. Five categories are discussed: (1) Educational Content or Value, which judges accuracy of content,

appropriate grade level and educational effectiveness in that setting; (2) Ease of Use; (3) Level of Student Interest; (4) Use of Microcomputer Capability; and (5) Support Materials, which assesses the effectiveness of the documentation. Special strengths and weaknesses of the program are also addressed in the critique. The final section presents a summary of the key features of the program in a few short paragraphs.

4. Other Evaluation Plans

Other evaluation strategies are being developed and are expected to come into use soon. Agencies which have published their intent to become involved in courseware evaluations include EPIE (Educational Products Informational Exchange) and Microsift (Microcomputer Software Information For Teachers).

As shown here, a number of approaches to the evaluation of CAI courseware are possible. The approach used by JEM has already been discussed in Chapter I. Some have a basis in classroom trial and teacher input, and some do not. It remains to be determined how well the approach adopted by JEM is suited to the needs of B.C. elementary school classroom teachers.

CHAPTER III

THE DESIGN

Overview

The chapter is divided into three sections. The "Research Design" describes the approach to be used in testing the hypothesis. The "Procedures" establishes the origin of the three sources of data which will be analyzed in the study. The contribution of each source and its relationship to the other sources is described under the separate headings. The "Rationale" discusses the research method used, and the reliability and validity of the research instruments chosen.

Research Design

The following null hypothesis was tested:

H_o: *There is no difference between evaluation statements derived from analysts applying the JEM evaluation model and the evaluation statements considered important by teachers.*

The hypothesis was tested with a posttest only control group design (Campbell and Stanley, 1963). The statements derived from the JEM Evaluation Model were compared with statements considered important by classroom teachers. The statements communicated information about various educational aspects of the courseware, and were rated on a scale of

one (useless) to 10 (extremely important) by a group of teachers experienced in the classroom use of CAI.

The educators who acted as analysts for JEM were assigned to the control group. They were experienced teachers familiar with the operation of microcomputers and a wide range of CAI courseware. The classroom teachers who were interviewed and had completed a questionnaire were assigned to the experimental group. They were also experienced teachers familiar with the operation of microcomputers and a wide range of CAI courseware. In addition, they were also experienced in the classroom use of the courseware. The treatment then, was in the actual use of the courseware with students.

Section Two of the questionnaire presented to the interviewed group of teachers provides the statements which allow the hypothesis to be tested. Embedded in the list of the 19 elements are a number of statements which are not provided by the JEM Evaluation Model, since they require teacher input. Should the teachers responses indicate that such information is unimportant, then the present model would be considered to be serving the needs of teachers adequately. If the results should indicate that such information is important, then the JEM model will be considered less than adequate.

Procedures

A. JEM Courseware Evaluation Checklist

It was the original intention of the JEM research team to base courseware evaluations on data collected through classroom trials. However, since CAI courseware had to be provided to pilot schools at the beginning of the implementation in September, 1980, no user data was available. The courseware descriptors were developed as a guide to teachers until more complete data could be collected. A four page questionnaire (the "Courseware Evaluation Checklist") was supplied to the pilot schools to facilitate data collection. Since only a limited number of these evaluation forms were returned (approximately 18%), there was not sufficient data to permit much application towards their intended purpose. However, 19 forms were obtained and loaned to the author for the purposes of this study. A copy of the checklist is enclosed in Appendix B.

This data was treated in two ways to yield useful evaluation and implementation information. The programs were categorized and tabulated to show the present areas of strength and weakness in currently available CAI courseware. A number of teachers attached comments to the form; the contents of these comments were categorized, tabulated and compared with relevant comments contained in the JEM Courseware Descriptors.

B. JEM Courseware Descriptors

Another source of data was provided by the Courseware Descriptors published in the JEM Reference Manual (Forman, 1980), which describes most of the available MECC CAI materials. This information was used to construct ratings of sample programs available in the core subject areas (Mathematics, Science, Language Arts, and Social Studies) and categorized according to quality of program. Samples from the rated categories were used in the design of the questionnaire, as will be discussed in the next section.

C. Interview and Questionnaire

The final source of data to be considered was collected by the author from experienced elementary school teachers who have been involved in the classroom use of CAI courseware with the microcomputer. Field trials with the interview and questionnaire technique established that advantages existed with each approach, and that to some extent, the advantages of both could be gained by combining the two techniques. Since it was found that a working relationship was much more easily established if the data collecting began with a conversation, the interview technique was used first (see Appendix D), followed with a three page questionnaire (see Appendix E).

The interview and questionnaire were kept as short as possible, required about 15 to 20 minutes to complete, and were administered by the author. Due to the small number of individuals involved in the

study, randomization was not a practicable way to achieve equivalency between the control group and experimental group. Instead, the individuals in the experimental group were matched to achieve equivalency to the control group. The twelve teachers assigned to the experimental group were selected so as to be similar to the individuals in the control group in teaching experience, familiarity with microcomputers, and knowledge of CAI courseware. All were experienced teachers: none had less than five years experience, and several had more than 20. Nine of the sample were teaching in urban settings, and three taught in rural schools. Eight of the sample were involved in the JEM Pilot Project, and nine had access to the Apple II microcomputer. The subjects obtained were from five different schools and the grades taught ranged from three to seven.

A limitation of the interview technique is that the subject may be motivated to provide answers which will please the interviewer, rather than express their own convictions. The author made an effort to control this factor by explaining the purpose of the interview, accepting all responses in a positive manner, assuring the subjects that their information was to be treated as confidential and that their individual viewpoint was of interest. A limitation of the questionnaire method is that questions can often be misinterpreted by the subject, and the answers can be misinterpreted by the researcher. As the interviewer was present as the questionnaire was being completed, any problems could be clarified immediately. It was felt that with the combination of the two techniques, some of the weaknesses of each

method were overcome to some extent while the advantages of each were gained.

Part of the interview data was summarized so as to produce a list of features B.C. elementary school teachers consider to be important components of quality CAI courseware. Such a list could be useful in checking the validity of the "Summary of Instructional Design Features" used by JEM to analyze courseware, and guide teachers in the development of quality CAI materials.

The first section of the questionnaire contains five programs of high quality derived from inspection of the Courseware Descriptors, and appropriate to the elementary grade level. The remaining programs had some form of limitation which placed them in categories ranging from acceptable to poor. The results of the teacher choices are categorized to show the degree of selectivity encountered and the degree of agreement with the derived ratings.

The second section of the questionnaire was designed to collect the data required to test the hypothesis, and to determine what kind of information teachers find most useful in courseware evaluations. The elements listed were extracted from courseware evaluations obtained from different sources and published for the use of teachers. Each element was rated on a scale of one to 10 according to the teachers view of their importance. The ratings were categorized in two ways: according to source or according to content. In the category determined by source, six of the elements deal with information not based on teacher use or classroom trial, and so could be gathered by

an analyst through direct examination of the courseware. This represents the information most commonly reported in courseware reviews. Eight elements require collection of data from teachers based on classroom trial. In the third group, the five elements would likely be evaluated most accurately if both sources, the teacher and the analyst were considered together. The mean value from the three sources rated were tabulated and compared.

The ratings were also categorized according to content to determine if any particular information category deserves special emphasis in courseware evaluations. The means derived from the ratings of elements in each category were tabulated to provide evidence for determining what content teachers feel is important in courseware evaluation.

Results of Section Three were tabulated to determine if common patterns of approach exist in teacher evaluation and decisions related to courseware selection. Section Four was tabulated and analyzed to determine if teachers changed their emphasis on CAI materials as they progressed in their implementation of microcomputers. Data in Section Five was summarized and contrasted with the data collected in Question Three of the interview.

Rationale

With the adoption of the microcomputer for delivery of CAI, we are in the earliest stages of a new development in education. A research technique which is versatile and flexible, and will allow investigation of the event in its natural setting is indicated. The survey technique is useful for determining the current status of phenomena, and can provide useful information on which to base future decisions (Mouly, 1978). Since the current status of an evaluation system was under investigation, the survey technique appeared appropriate.

The problem of establishing the reliability and validity of survey instruments poses a problem which is difficult to handle in such studies. The validity of any of the sources of data on which this study is based may be considered weak when viewed in isolation. However, the validity of the instruments used rests on their collective support of each other. In the design of the Interview and Questionnaire, an attempt was made to check the reliability of the other instruments used in this study. For example, if it can be established that teachers actually used the "Courseware Descriptors" and considered the information useful and relevant to their teaching, the finding helps to validate the "Descriptors" as a reliable source of data. For that reason, a question on the teacher use of the "Courseware Descriptors" was included in the interview.

The validity of the data rests largely on authority. The JEM research staff are recognized as experts in the area of educational use of microcomputers. Two of the sources of data utilized in the study were materials prepared by them. A third source of data (the combined interview and questionnaire) was in part derived from the JEM materials, and so derives its validity through this association. It was designed in order to test the validity of the JEM model, and determine if the teachers were able to obtain useful evaluation information from application of the model.

Another way in which validity and reliability can be strengthened is through the findings that appear on analysis of the data. If findings appear which are supported from data derived from several independent sources or samples, then validity is gained. The common findings help to establish that the instruments are supporting one another.

CHAPTER IV

PRESENTATION AND INTERPRETATION OF DATA

Nineteen JEM Courseware Evaluation Checklists were returned by six elementary school teachers from two schools. Table 1 tabulates the checklist responses. In most cases the total number of responses equals 16 rather than 19, since three forms were not completed, but were used to communicate a comment only. In cases where the total is less than 16, one or more respondents did not complete that item.

Some weaknesses in the design of the CAI materials are revealed by the data, and include lack of effective classroom management systems, lack of tutoring responses to aid weak students, lack of any form of documentation, and insufficient emphasis on providing clear directions to students.

It was particularly interesting to note that this group of teachers reported a higher proportion of execution problems than did the analysts. Of the 16 different programs evaluated by the teachers, three or 19% were reported to have execution problems. A survey of JEM Courseware Descriptors revealed that the analysts reported execution problems in only six per cent of the elementary level CAI programs. This difference suggests that teachers are in a better position than the analysts for finding exeuction problems. The more times a program is run, the more likely any error present will be detected. Through supervision of their students, teachers are likely to observe more trial runs than the analyst, and so are more likely to detect execution errors.

The checklist is also useful in locating areas of strength in the

Table 1

Tabulation of Results from Courseware Evaluation Checklist

Completed by Elementary School Teachers

COURSEWARE EVALUATION CHECKLIST

Name of Progam: _____

Name of Diskette: _____

Type of Program: _____

Subject Area: _____

Grade Level: Ranging from Grade Two to Grade Six

Peripheral: _____

Memory: _____

Source: B.C. elementary school teachers involved in JEM Pilot Project

	Yes	No	Not Relevant
1. The subject matter of this package is central to the field.	11	1	5
2. The content is consistent with the goals and objectives of the established curriculum.	12	0	4
3. Where appropriate, as in drill and practice, individualized instruction, remediation, or enrichment activities, there are diagnostic procedures built in.	4	8	3
4. Evaluative procedures.	14	1	1
5. Review procedures.	11	2	3
6. A classroom management system.	2	11	3
7. The program is one of a series in which a carefully planned sequence of learning objectives has been followed.	7	6	3
8. The microcomputer is the best available method for presenting these materials.	6	3	7
9. The material is clearly and attractively packaged.	13	2	0
10. Students enjoy using the program.	15	0	0
11. The program will run right through without becoming "hung-up" because of unexpected response.	12	3	0
12. The "escape" directions are repeated at timely intervals throughout the program.	12	3	0
13. When the student is confused, help can be obtained.	8	6	2
14. The student is not trapped in a situation where a repeated incorrect response results in the same question being repeated over and over again.	15	0	0

	Yes	No	Not Relevant
15. Depending on the complexity or purpose of the program, the branching capabilities of the microcomputer are used when a student obviously shows that some tutoring or further information is required before proceeding.	3	11	2
16. Feedback as to whether the student's response is correct or incorrect, is immediate.	15	0	1
17. Positive reinforcement and encouragement are given intermittently.	14	1	1
18. Reinforcement is positive, appropriate, dignified and not time consuming.	11	3	2
19. Directions are accompanied by useful examples where appropriate.	5	9	1
20. The student can choose to see the directions again.	9	8	0
21. Sound is used only when it is essential.	12	2	1
22. Colour, graphics, and animation are used only when they enhance the lesson.	14	1	2
23. Advantage is taken of the interactive capabilities of the microcomputer.	12	0	4
24. Protocols of communication from the user to the computer are logical and unvarying.	14	1	0
25. The student is never left with a blank screen and no indication of what is happening.	12	3	0
26. The program ends with some suitable directions for the student.	14	0	1
27. The program operates at the rate of the person sitting at the keyboard.	15	1	0
28. The material is appropriate for the target grade level in terms of prerequisite basic skills.	15	0	1
29. Documentation is available.	7	9	0
30. The text obeys the strictest rules for punctuation, capitalization, grammar, spelling and usage.	11	1	3
31. Words and lines are spaced for ease of reading.	12	2	0
32. The use of space on the entire screen is effective.	13	0	0
33. Variation in type and organization of textual materials are appropriate for a clear presentation.	13	0	2

Description and Comments:

courseware evaluated. One could include as strengths that the content is consistent with the goals and objectives of the curriculum, the programs and with suitable directions for students, and the students enjoy using the programs.

Table II presents a sample of the teachers' comments submitted on the checklist, and compares them to the comments published in the JEM Courseware Descriptors. In total, seven MECC programs were reviewed by teachers for which JEM evaluations were done. Comparisons between the two sets of evaluations did not disclose any major incongruities between them. There were some minor differences, however, as can be noted from the table, not only between the teachers and the JEM analyst, but also between the different teachers. The complete text of the teachers' comments is given; only the relevant sections written by the JEM analyst are provided in the table. The full text of the Courseware Descriptors for the "Milliken Math Sequence" and "Hurkle" are given in Appendix B.

It appears as though a programming error exists in one of the Milliken sequences that was not observed by the JEM analyst. Teachers reported errors in some other programs as well which were not reported in the Courseware Descriptors. This difference suggests that teachers using the courseware with students might be in a better position to detect faults in the courseware than are analysts working independently from the classroom.

It was noted that teachers using "Hurkle" appeared to differ somewhat in their opinion of the program. The writer speculates that respondent B was using the program at a higher grade level than was respondent A, although the grade level was not specified by respondent B.

Table II

Comparison of Judgements on Courseware Between Teachers and JEM Analyst

Teachers' Judgements (From Courseware Evaluation Checklist)	JEM Analyst's Judgements (From Courseware Descriptors)	Present (+) or Lacking (-) in Courseware Descriptors
	Regarding Milliken Math Sequence	
Respondent J.		
Over use of graphics.	. . . the quality of graphics, the reinforcement techniques, the pace and the	+
Tends to get boring.	drill need improvement.	+
Is an excellent vehicle for drill.	. . . with some revision, could be an excellent aid to teachers.	+
Extremely high motivation amongst students.	(Not discussed.)	-
Respondent K.		
Some execution problems. Students left with no results recorded because of unknown erorrs which appeared for no apparent reason.	(Not discussed.)	-
	Regarding Hurkle	
Respondent H (Grade level: 3)	Grade Level: 3 to 8	+
Hurkle is one of the biggest hits of all! The animated character and sound effects certainly capture the interest of children.	. . . sound, animation and graphics make this an enjoyable program . . .	+
Respondent I.		
Useful for lower level students' thinking skills.	(Not discussed.)	-
Interest is short lived, however.	(Not discussed.)	-

The grade range provided by the JEM analyst may have been too broad. During the interviews with teachers, several stressed the importance of matching the program to the appropriate grade level. These indicators suggest that correctly prescribing the appropriate grade level is of considerable importance. If that is the case, teachers might play a useful role in confirming the analyst's grade level classification. The overall impression formed by the writer was that the statements provided by the teachers served to extend and broaden the analyst's representation of the courseware, and complemented the analyst's view.

It was found that the teachers' comments could be classified according to categories of judgements made. Most judgements were of a subjective nature, and dealt with the individuals' personal impressions derived through observing the reactions of individual students. Since an inductive reasoning process underlies such judgements, they were categorized as Inductive Judgements. Inductive judgements were found to be of three types:

1. Critical Judgements:

   --described some strength or weakness of the courseware.

   e.g. . . . I find this program frustrating to use because of all the reinforcement built in. . . . It is not meaningful in the context in which I want to use the program.

2. Assessment Judgements:

   --gave a rating for some feature of the program in a very general context. e.g. . . . Excellent program! Students enjoyed using it.

3. Prescriptive Judgements:

   --gave an assessment in a very specific context, and told how the program could or should be used. e.g. . . . Useful for lower level students thinking skills. . . . Useful for review.

Some comments presented information in which less judgement was exercised. These were considered more objective in nature, since they dealt with features which required less personal interpretation. Since a more deductive reasoning process appeared to underlie such judgements, they were termed Deductive Judgements. Two categories of Deductive Judgements appear to be involved in courseware evaluations, but only the first of these received attention in the comments of the teachers.

1. Descriptive Judgements:

   --objective statements that described or explained some aspect of interest about the program; little judgement required. i.e. . . . Students can put their own list of words into the program. . . . The user can select a fast, medium or slow pace for the program.

2. Identifying Judgements:

--objective statements that named or identified the program and where it can be obtained, and told what system and peripherals are required to run it. Such information is essential to any published courseware evaluation, but was not the subject of teachers comments.

The four categories present in the teachers' comments were tabulated for each evaluation as shown in Table III. From this data, the writer concluded that teachers consider inductive judgements to be of considerable importance, as many more inductive statements were recorded than deductive statements, and a greater portion of returns contained statements in inductive categories than deductive ones. Since they feel it important to communicate inductive judgements about CAI courseware, these judgements must carry considerable meaning to the teacher who writes them. It is evident that teachers could provide evaluators with a rich source from which to draw inductive information if it is seen to be useful. The question is, do such inductive judgements carry enough meaning to other teachers to support incorporation of such judgements into courseware evaluations? Data from the part of the questionnaire designed to resolve that question is summarized in Table IV.

Embedded in the 19 statements listed in Table IV are elements which would correspond to each of the types of judgements mentioned previously except the identifying judgements. Also included is a column which indicates whether or not such judgements are normally

Table III

Teachers' Comments From Courseware Evaluation Checklist Categorized According to Judgements Expressed

Respondent to Evaluation Checklist	Judgements			
	A. Inductive			B. Deductive
	Assessment	Critical	Prescriptive	Descriptive
A	* *	* * *		
B	*	* *		
C	*		*	
D			* *	
E		*		* * *
F	*		*	
G		*		*
H	*	*		
I		*	*	
J	*	**	*	
K				* *
L			*	
M	*	*	*	
N			*	*
O			*	*
P			*	
Q	* * *			*
R			*	
S	*	* *	*	*

* 1 statement

** 2 statements

*** 3 or more statements

Table IV

Evaluation Elements Rated by Interviewed Teachers for Importance in Decision Making

Elements (order as contained in questionnaire and rated for importance on a scale of one (useless) to 10 (extremely important)	Mean	Range	Present (+), Absent (-) in JEM Courseware Descriptors
1. Recommended grade level.	7.2	1-10	+
2. Description of how the student is supposed to interact with the program.	6.8	5-10	+
3. Description of how the student actually interacts with the program.	5.8	1-10	-
4. Limitations of the program.	7.8	4-10	+
5. Strengths of the program.	8.7	5-10	+
6. Reasons for teacher acceptance of program.	5.8	1-8	-
7. Reasons for teacher rejection of program.	5.8	1-8	-
8. Outline of stated objectives of the program.	9.0	7-10	+
9. Assessment of the instructional design.	7.8	5-10	+
10. Description of documentation.	8.1	5-10	+
11. Description of reinforcement provided.	7.1	5-10	+
12. Assessment of the effect of reinforcement on student behaviour.	6.7	2-10	-
13. Assessment of the quality of graphics, animation and sound.	7.2	4-9	+
14. Level of student interest with program.	7.0	1-10	-
15. Degree to which students were able to achieve stated objectives.	8.0	5-10	-
16. Suggestions for improvement of program.	8.1	6-10	+
17. How to integrate the program with the regular curriculum.	7.8	2-10	-
18. Suggestions for effective use of program.	7.3	3-10	+
19. Teacher rating of program based on classroom trial.	7.2	5-10	-

presented in the JEM Courseware Descriptors. Each of the items was rated on a scale of one (useless) to 10 (extremely important), and completed by the 12 interviewed teachers. The author was rather surprised to discover that in a number of elements a great range of response occurred. This was interpreted to indicate that teachers vary in their evaluation requirements; some place more emphasis on certain elements than others, perhaps because of their particular teaching style. If this interpretation is correct, it implies that a narrow and restricted approach to providing evaluation information will not meet the needs of all teachers. It was also noted that the outline of stated objectives and the strengths of the program were most highly rated of all, while description of how the student actually interacts with the program, and reasons for teacher rejection of program rated lowest.

Tables V and VI order the responses summarized in Table IV into two categories. Table V shows that the inductive judgements are considered as useful by teachers as the more deductive judgements in terms of helping teachers select suitable courseware, since little difference exists between the subjective and objective ratings. This finding would seem to support the inclusion of the three types of inductive judgements into courseware evaluations.

Table VI shows that the teacher only source did not rate as high as the other categories, although it rated high enough to be considered important. Since some of the individual elements which required teacher input were rated highly and others considerably lower, these

Table V

Evaluation Elements From Table IV Rated According to Judgement Category

No. of Elements	List of Elements	Judgement Category	Mean
6	9, 12, 13, 14, 15, 19	Assessment[a]	7.3
5	4, 5, 6, 7, 16	Critical[a]	7.2
3	1, 17, 18	Prescriptive[a]	7.4
5	2, 3, 8, 10, 11	Descriptive[b]	7.4

[a] Inductive Group Mean: 7.3

[b] Deductive Group Mean: 7.4

Table VI

Evaluation Elements From Table IV Rating According to Source of Information

No. of Elements	List of Elements	Source of Information	Mean
6	2, 8, 9, 10, 11, 13	Analyst	7.7
8	3, 6, 7, 12, 14, 15, 17, 19	Teacher	6.8
5	1, 4, 5, 16, 18	Analyst and Teacher	7.8

results are interpreted to mean that teacher judgements should be focused on specific aspects. Teachers could provide useful evaluation information by focusing their judgements to certain key areas, such as strengths and weaknesses of the programs, degree to which students were able to achieve stated objectives, suggestions for improvement of the program, and other areas rated important in the table.

The data that is contained in Tables IV, V and VI show that some important information is not being presented in the Courseware Descriptors. Since it has been shown that a difference exists between the evaluation statements considered important by teachers and those provided by the Courseware Descriptors, the null hypothesis is rejected. A model which would include the teacher as a source of evaluation data appears to be more in keeping with the teachers' evaluation requirements.

Table VII presents further evidence to suggest that classroom teachers have a role in evaluation. The average value for the elements currently used in the Courseware Descriptors was 7.7 (calculated from Table IV). Yet when teachers rated the usefulness of the Courseware Descriptors as an evaluation approach (see Table VII), a lower value of 6.9 resulted. This difference may be explained if the average values from Table IV are considered as what is theoretically attainable if teachers have full confidence in the evaluation product. Confidence in the Courseware Descriptors may be lacking because input from classroom teachers experienced in the trial use of the materials is lacking.

A difference was also noted in the separate ratings recorded for teacher recommendation as an evaluation approach. This difference may be explained in terms of the source of the recommendation. Teacher recommendations recorded in print could not be expected to carry as much influence in teacher decision-making as recommendations obtained directly from colleagues. The lower value (7.2) found in Table IV is based on recommendations recorded in print, while for the higher value (7.0) obtained in Table VII it is implied that the recommendations are obtained directly from colleagues.

Table VIII suggests that delivery of CAI is now the most important use of the microcomputer at the present time in the province. It also appears to hold relatively more stable in comparison to other uses which appear to have fluctuated during the course of the year. Since CAI is playing a dominant role in the educational use of the microcomputer, concern for effective evaluation approaches seems well placed.

Table IX shows that teachers are highly selective in their judgement of which programs are acceptable for classroom use. Two programs were not selected at all, and most received a limited number of selections. The programs most often used in the classroom and judged acceptable by the teachers were those the JEM analyst had highly recommended. The hypothesis that no significant difference exists between the number of programs used in each category was tested with a chi-square analysis (Popham and Sirotnik), as shown in Table X.

Table VII

Evaluation Approaches Rated by Interviewed Teachers for Importance in Decision Making

Evaluation Approach	Mean	Range
1. Recommendations from other teachers.	7.9	5-10
2. Personal evaluation through inspection of program.	9.3	8-10
3. Trial use with a group of students.	8.8	5-10
4. JEM Courseware Descriptors*	6.9	5-8

*Based on eight responses from teachers who were in Pilot Project, and were users of the Courseware Descriptors.

Table VIII

Pattern of Microcomputer Use at Beginning and End of Pilot Project (September 1980 to June 1981)

Type of Use	September	June
1. Commercial CAI Courseware (excluding non-educational games)	32%	35%
2. Teacher Prepared Courseware	13%	24.5%
3. Programming Activities	13%	32%
4. Games (non-educational)	42%	8.5%
	100%	100%

Table IX

Variations in Interviewed Teachers Use of CAI Programs Compared With Ratings Derived From JEM Courseware Descriptors

GROUP A: Highly Recommended Programs

	Program	Subject Area	No. of Users
1.	Hurkle	Math	8
2.	Speed Drill	Math	6
3.	Odell 1	Science	5
4.	Spell	Language Arts	6
5.	Prefixes	Language Arts	5
		Total	30

GROUP B: Programs Not Highly Recommended (ranging from Acceptable to Not Recommended)

	Program	Subject Area	No. of Users
1.	Tens	Math	0
2.	Talk	Language Arts	2
3.	Odell 2	Science	3
4.	Ursa	Science	3
5.	Continents	Social Studies	2
6.	States	Social Studies	0
7.	Sumer	Social Studies	2
8.	Metric 21	Math	2
9.	Bagels	Math	2
		Total	16

Based on responses from eight teachers who were in pilot project, and had access to all programs listed.

Table X

Chi-square Contingency Table

Highly Recommended	Not Highly Recommended
30 (16.4)	16 (29.5)

Expected frequencies in parenthesis $x^2 = 17.4$

Critical value is 10.8 at .001 level

Since the result was significant, the null hypothesis was rejected, and the hypothesis that a significant difference exists was accepted. Since the differences do not appear to be due to chance, the teachers and the JEM analyst seem to be in agreement in their recommendations for those two categories.

This finding, however, raises the question as to whether the agreement between the analysts and teachers is due to the influence of the Courseware Descriptors, or the result of the two groups arriving at similar conclusions independently. If the value rating and ranking of the influence of the Courseware Descriptors in Table VII accurately reflects the level of importance attached to that evaluation approach, then it could be argued that the teachers are arriving at the same conclusions as the analysts more or less independently. But since most teachers involved in the pilot study claimed to use the Courseware Descriptors, it could also be argued that the evaluations influenced the outlook of the teachers. Unfortunately, data to clearly resolve the issue was not available.

Whichever explanation applies, the finding appears to further validate the JEM evaluation approach. It adds support to the position that the JEM evaluation model need not be replaced with drastically different evaluation approach, but merely modified and refined to increase its influence and effectiveness.

In the questionnaire, the teachers were asked what they considered to be the main limitations of CAI courseware presently available. Most often mentioned was that the courseware did not match the B.C. curriculum adequately. Several teachers mentioned that the content of some programs is too American in orientation, particularly in Social Studies and Science. Availability of courseware was also frequently mentioned as a problem. Teachers find it difficult to locate and obtain good courseware, and the costs are high for what is available. Quality control was also seen as a problem. Some programs duplicate objectives just as readily achieved through use of traditional approaches. Some programs appeared to teachers as having been written by programmers rather than educators. A summary list of the limitations mentioned is given in Appendix G.

In the interviews, the teachers were asked what they considered to be the most important features of good quality CAI courseware at the elementary school level. The most often mentioned feature was colour graphics capabilities. Providing they are relevant to the grade level and not too time consuming, colour graphics are very appealing to the students. A list summarizing the teacher responses is provided in Appendix H.

CHAPTER V

DISCUSSION AND RECOMMENDATIONS

The results of the survey show the following findings apply to the group of elementary school teachers sampled:

1. Not all the information that teachers considered important was being provided by the JEM evaluation model. The information lacking could be provided by teachers who have used the courseware in their teaching, and should include the following:
   (a) the degree to which students were able to achieve the stated objectives;
   (b) how to integrate the program with the regular curriculum;
   (c) a teacher recommendation or rating based on classroom trial; and
   (d) the level of student interest in the program.
2. The JEM Courseware Descriptors were useful to teachers and provided information helpful in the selection of CAI courseware. In the core subjects, courseware highly recommended by the JEM analysts was found to be the courseware most used and recommended by the teachers.
3. The evaluation approach rated most useful by teachers was personal inspection of the courseware.
4. The limitation of currently available courseware most often mentioned was lack of relevance to the B.C. curriculum.

5. The feature most often mentioned as an important component of quality courseware was colour graphics capabilities.

Discussion

Consideration of these findings leads the writer to a number of generalizations which may have important implications to the future implementation of CAI courseware in B.C. elementary schools.

Teachers appear to be highly selective in their use of CAI materials, and high levels of use normally appear only for the highest quality courseware, as rated by JEM analysts. This is seen as evidence that the present system of courseware evaluation is serving a useful purpose in that quality courseware can be identified and brought to the attention of teachers. The pattern of elementary teacher use appears to validate the JEM approach.

Teachers were also discovered to extend the perception of the JEM analysts, and observe features relevant to the evaluation of the courseware which the analyst may overlook, or not be in a position to judge. It is suggested that this situation arises because the teacher's focus is on the students, and they arrive at their judgements through a more inductive process. The analyst's focus is on a set of criteria to which the courseware is matched through a more deductive process. The teacher's inference is from a set of specific responses from individual students from which general interpretations are drawn, while the analyst's inferences are derived from a general set of criteria which is applied to the particular program under analysis. The writer sees

the two processes as complementary, and each contributes judgements which extend the viewpoint of the other. The two viewpoints taken together should provide a more useful and complete evaluation of the courseware.

Teachers were found to view the Courseware Descriptors produced by JEM as a useful tool in helping to select suitable courseware for their students. However, several other approaches such as recommendations from other teachers were rated as more important than the Courseware Descriptors. It is suggested that one way to improve the usefulness of the Courseware Descriptors would be to communicate the recommendations of teachers familiar with the classroom use of the particular item of courseware.

Evidence from implementation studies indicates that teacher resistance to change will occur unless teachers have a major role to play in the development of innovation. Involvement of the teachers in evaluation of courseware would be one way of bringing teachers into the implementation process in a real and useful manner.

Recommendations

The findings of the study as a whole provide support for the position that B.C. elementary school teachers should have a role to play in the evaluation of CAI courseware considered for use in the provinces elementary school system. The writer has developed an evaluation model based on these findings, which illustrates the nature of teacher involvement which is considered to be most likely to be

effective. A model to illustrate the nature of the involvement is illustrated graphically in Figure 3. The model is essentially a refinement and extension of the approach pioneered by the JEM research team. The major change is that teachers are given an important role in the evaluation process, and their judgements incorporated into the final written evaluation product.

As the model indicates, a team approach involving a small group of teachers and an analyst would be required. The role of the analyst would be similar to the present role, and would require much the same skills. The analyst would act to screen out materials that are obviously unsuitable or inadequate for educational purposes in the B.C. elementary school system. The analyst would also need to assess the most suitable grade level to consider for use of the materials, and make the courseware available to the appropriate teachers.

The teachers willing to pilot the courseware should be surveyed with an evaluation instrument which would collect their judgements in three areas:

1. Critical Judgements:

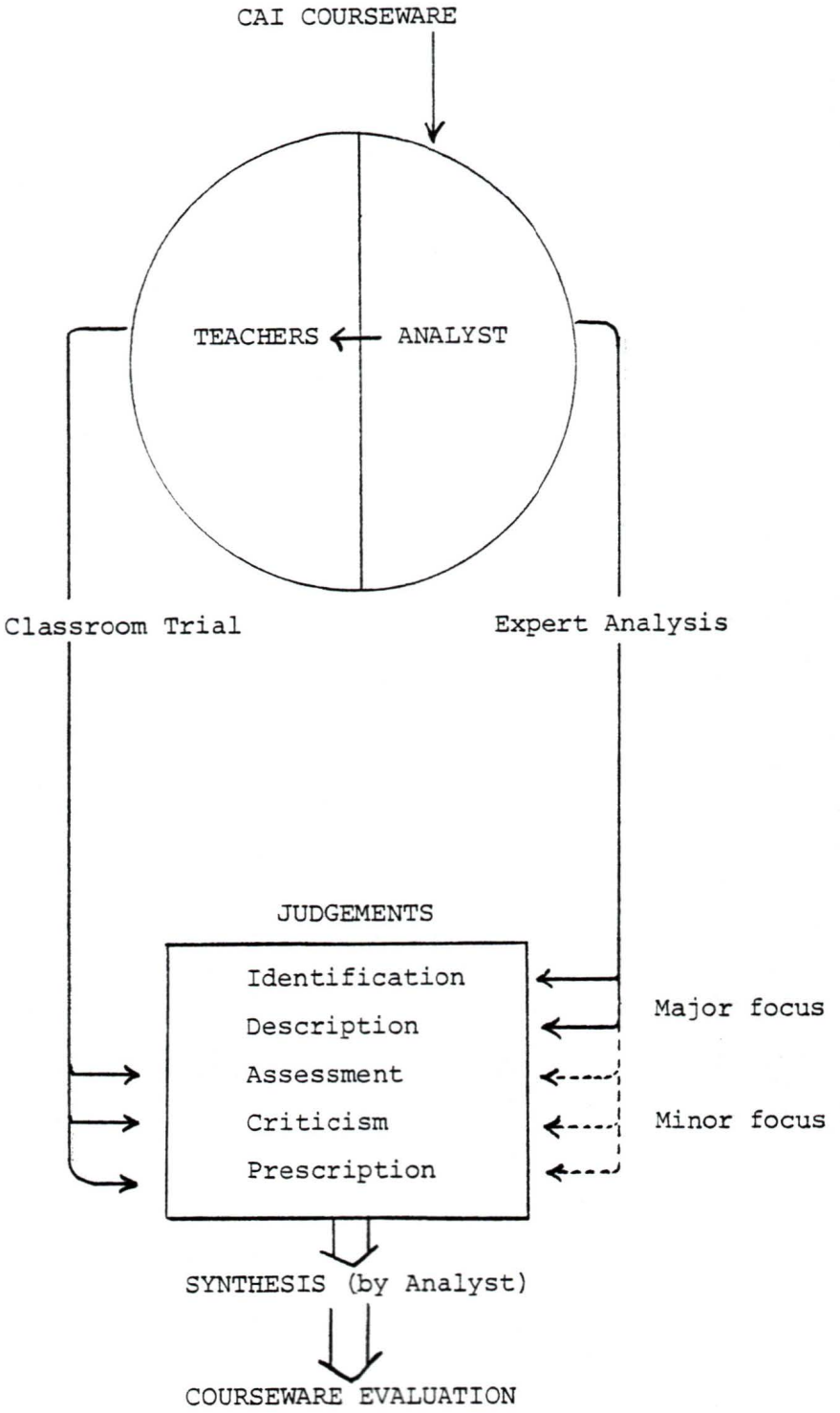
   --determine the strengths and weaknesses of the courseware through observing the students interacting with the program.

2. Prescriptive Judgements:

   --determine if the courseware is suitable for the grade level predicted by the analyst, judge how the program can be most effectively used.

Figure 2

The Eclectic Model for Evaluation of CAI Courseware



3. Assessment Judgements:

--assess the degree to which students were able to meet the stated objectives of the program, assess the overall educational usefulness and quality of the program, establish the degree to which the individual teacher recommends the program to others (ranging from not recommended to highly recommended).

The collection of this data does not require a lengthy questionnaire to obtain. Any instrument used must be short and easily completed as the work load of most teachers is very great, and little time is available for extra assignments. Low rates of return can be expected if the questionnaire exceeds one page in length, and requires more than a few minutes to complete.

The analyst focuses mainly on judgements in two categories:

1. Identification Judgements:

--Clearly identifies the program, the cost, the documentation provided, the source from which it can be obtained, and the type of microcomputer and peripherals required to run the program. Such information is essential for teachers to know for any program they may be interested in obtaining.

2. Descriptive Judgements:

--Objective statements that describe or explain important aspects of the program. Statement of learning objectives and explanations about what the courseware does come under this category.

On return of the teachers' data, the analyst is in a position to synthesize and incorporate their responses into the final evaluation summary. The end result should be a more balanced representation of the courseware than is now provided for the teacher, and one the teachers should feel comfortable in consulting, since they play an important role in its development.

Teachers indicated in the survey that personal inspection was the most helpful approach to making effective decisions about the use of courseware. This suggests that materials should be made readily available to teachers on loan from a central lending service. Borrowing could be on the condition that evaluation data be returned with the courseware. If teachers were to indicate which materials appeared to satisfy their requirements, and orders were placed through the central service, savings could likely be achieved through bulk purchasing. Data on what is of use to teachers could be compiled at the same time.

Suggestions for Further Research

The evaluation model developed in this study was meant to deal with the type of courseware which is most commonly available now. At present, most of the courseware deals with short, independent topics rather than extensive, interrelated units of study. Will teachers show a preference for courseware which is sequenced so as to cover comprehensive areas of a course? If so, evaluation models appropriate for such systems will need to be devised.

Some evidence to support that the present type of courseware may eventually be replaced was encountered in this study, in that the greatest number of volunteered Courseware Evaluation Forms were for the Milliken Math Sequence, which is a comprehensive elementary school mathematics program. This occurence was somewhat surprising, since the Milliken Math was reported to contain a number of serious inadequacies by JEM analysts, and at a cost of about 300 dollars, it is quite expensive for any school to purchase. What could be the source of the strong appeal which this program appears to hold for classroom teachers?

The program was designed to provide individual drill and practice in mathematical operations that have been previously taught. It claims to correlate well with most basic elementary school mathematics texts. In the view of the JEM analyst, its appeal lies in the fact that it is a comprehensive and carefully documented sequence of steps and tasks to provide drill and practice in every aspect of basic mathematical operations from Grades 1 to 6 (Forman, 1980).

Programs such as the Milliken Math Sequence demand a significant share of a school's financial resources, and have the potential to replace a substantial amount of the traditional course material. Such courseware must be of the highest quality, and should be clearly superior to what is being supplanted. Its effectiveness should be carefully verified before its widespread use is authorized or encouraged. A more rigorous form of evaluation may be needed to ensure that such programs fully meet the requirements set for them.

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APPENDIX A

Permission to Reproduce Materials

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research
Joint Educational
Management Research

August 10, 1981

To: Bruce Green

This letter grants you permission to reproduce materials from the JEM Reference Manual Volume I to be used in the appendix of your thesis.

Denyse Forman
Research Associate

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APPENDIX B

JEM Courseware Evaluation Checklist

COURSEWARE EVALUATION CHECKLIST

Name of Program: _____
Name of Diskette: _____
Type of Program: _____
Subject Area: _____
Grade Level: _____
Peripheral: _____
Memory: _____
Source: _____

	yes	no	not relevant
1. The subject matter of this package is central to the field.			
2. The content is consistent with the goals and objectives of the established curriculum.			
3. Where appropriate, as in drill and practice, individualized instruction, remediation, or enrichment activities, there are diagnostic procedures built in.			
4. Evaluative procedures.			
5. Review procedures.			
6. A classroom management system.			
7. The program is one of a series in which a carefully planned sequence of learning objectives has been followed.			
8. The microcomputer is the best available method for presenting these materials.			

	yes	no	not relevant
9. The material is clearly and attractively packaged.			
10. Students enjoy using the program.			
11. The program will run right through without becoming "hung-up" because of unexpected response.			
12. The "escape" directions are repeated at timely intervals throughout the program.			
13. When the student is confused, help can be obtained.			
14. The student is not trapped in a situation where a repeated incorrect response results in the same question being repeated over and over again.			
15. Depending on the complexity or purpose of the program, the branching capabilities of the microcomputer are used when a student obviously shows that some tutoring or further information is required before proceeding.			
16. Feedback as to whether the student's response is correct or incorrect, is immediate.			
17. Positive reinforcement and encouragement are given intermittently.			

	yes	no	not relevant
18. Reinforcement is positive, appropriate, dignified and not time consuming.			
19. Directions are accompanied by useful examples where appropriate.			
20. The student can choose to see the directions again.			
21. Sound is used only when it is essential.			
22. Colour, graphics, and animation are used only when they enhance the lesson.			
23. Advantage is taken of the interactive capabilities of the microcomputer.			
24. Protocols of communication from the user to the computer are logical and unvarying.			
25. The student is never left with a blank screen and no indication of what is happening.			
26. The program ends with some suitable directions for the student.			
27. The program operates at the rate of the person sitting at the keyboard.			

	yes	no	not relevant
28. The material is appropriate for the target grade level in terms of prerequisite basic skills.			
29. Documentation is available.			
30. The text obeys the strictest rules for punctuation, capitalization, grammar, spelling and usage.			
31. Words and lines are spaced for ease of reading.			
32. The use of space on the entire screen in effective.			
33. Variation in type and organization of textual materials are appropriate for a clear presentation.			

Description and Comments:

APPENDIX C

Samples of JEM Courseware Descriptors

DISK TITLE:	Elementary School, vol.1, ver.1
PROGRAM TITLE:	HURKLE
TYPE:	Educational Game
SUBJECT AREA:	Mathematics
GRADE LEVEL:	3 - 8
LANGUAGE:	Applesoft Basic
PERIPHERAL:	No
MEMORY REQUIREMENT:	32K
DISTRIBUTOR:	MECC
APPROXIMATE PRICE:	$30/U.S./disk

DESCRIPTION: Hurkle, a little man, hides on a horizontal or vertical line, a 10 by 10 grid or a -5 by +5 grid. The student chooses the line or grid. He is allowed five tries to find Hurkle and after each try, Hurkle tells him in which direction to look.

COMMENTS: The student must know his direction, North, South, East or West as clues are given by saying, "Go South West." The North, South, East, West, directions are not provided on the line or grid and the teacher would have to spend some time discussing maps and directions with the students. The negative numbers would be a problem for younger children as would the terms vertical, horizontal and grid. However, there are grade three children who could deal with these concepts and for those who couldn't, the choice of finding Hurkle on a vertical or horizontal line provides an easy and valuable exercise in logical, planned decision making and in working with number lines. The documentation including objectives and lesson plans is very good. Sound, animation and graphics make this an enjoyable program and the instructional design is very good.

DISK TITLE:	Middle School Science, vol.1, ver.1
PROGRAM TITLE:	ODELL
TYPE:	Problem Solving Simulation
SUBJECT AREA:	Earth Science
GRADE LEVEL:	3-7
LANGUAGE:	Applesoft Basic
PERIPHERAL:	No
MEMORY REQUIREMENT:	32K
DISTRIBUTOR:	MECC
APPROXIMATE PRICE:	$30/U.S./disk

DESCRIPTION: In this program, a food web in Odell lake is simulated. The user role plays a fish. After role playing all the fish, the student should be able to tell the relationships between the fish. The student is given five options as far as his actions in different situations are concerned. The lake and the fish are represented graphically. Depending on the option the student chooses, fish are seen eating or being eaten by other fish or by an osprey; they are shown escaping or ignoring other fish, or the student is told he has starved to death.

COMMENTS: Excellent documentation is available for this program. The graphics are very well done and the animation is highly amusing. A useful and most enjoyable program. Very well done.

DISK TITLE:	Milliken Math Sequences
PROGRAM TITLE:	TWELVE DIFFERENT PROGRAMS LISTED BELOW
TYPE:	
SUBJECT AREA:	Mathematics
GRADE LEVEL:	1-6
LANGUAGE:	Applesoft BASIC
PERIPHERAL:	Printer can be used
MEMORY REQUIREMENT:	32K
DISTRIBUTOR:	Milliken
APPROXIMATE PRICE:	$300.00/U.S.

Milliken Math Sequences - Applesoft

Math Sequences,	12 Diskettes for Apple II Plus + (32K)	$300.00
	12 Cassettes for Apple II Plus + (16K)	200.00
	12 Cassettes for TRS-80 (Level II, 16K)	200.00
	12 Cassettes for Commodore Pet (8K)	200.00
Replacement diskettes		@ 30.00
Replacement cassettes		@ 20.00

DESCRIPTION: The basic drill and practice software program for use with Apple II Plus or Apple II with Applesoft ROM card microcomputers contains twelve diskettes, a Teacher's Guide, four duplicating masters and an "Easy-Does-It" Card (step-by-step guide to operating the computer).

The Teacher's Guide describes the equipment, the sequences, and includes directions for using the package in the classroom.

The Math Sequences provide drill and practice for students in Grades 1 through 6 in the following mathematical operations:

- Addition (1 diskette)
- Subtraction (1 diskette)
- Multiplication (1 diskette)
- Division (1 diskette)
- Laws of arithmetic (1 diskette)
- Negative numbers (1 diskette)
- Fractions (2 diskettes)
- Decimals (3 diskettes)
- Percent (1 diskette)

According to Milliken, it correlates with concepts presented in most basic mathematical texts. They are designed to provide individual drill and practice for students in math operations that have already

been introduced by the teacher.

Each sequence contains problems which have been divided into problem levels, each level consisting of a number of problems falling within the same mathematical parameters. The mathematical parameters have been determined by the following criteria:

1. the range of numbers involved;
2. the number of steps involved in computation
3. the presentation of problems (vertical, horizontal)
4. special properties (multiplication by 10 is easier than multiplication by 9);
5. graduated level of difficulty.

The number of problems given at each problem level increases as difficulty increases. Problem levels are not equivalent to grade levels. There are as many as 100 problem levels in the Addition Sequence but only 16 in the Percent. A graph is provided to illustrate the problem levels in the Sequences and the approximate grade level at which a concept is generally introduced and practiced. Each correct answer is met with reinforcement (WOW, YOU DID IT! GREAT), while incorrect answers elicit a chance to try again. After two incorrect responses, the computer flashes the correct answer. Students are advanced after specific achievement criteria are met or moved back a level until mastery is achieved.

When a student has completed the minimum of problems at a particular level with an overall score of 70% or higher, he advances to the next level. If he misses three problems in a row or his score falls below 30% after the minimum number of problems have been worked, the computer drops the student one problem level. As long as the overall score is between 30% and 70%, the computer will generate problems at the given level.

A "Student Progress Chart" gives students a visual and/or written progress record of the percentage they received on each sequence; a "Class Evaluation/Progress Chart" indicates the problem level each student in the class has achieved in each sequence; and an Assignment Sheet shows each student his assignment number beginning and end level, the number of problems he has done, the number of problems he has done correctly and his score.

The Milliken Math Sequences contain a management system. Teachers enter student's names on each individual sequence diskette to be used, and make assignments for review and drill at specific problem levels. Each diskette holds a total of 100 student records and five class records.

Before he can have access to the programs, the teacher's name must be recorded on the diskette with his Grade and a password in a procedure called "Initialization". Once he has access to the program, he can turn to the Student Management Page which allows him to:

1. add a student to his class list;
2. delete a student;
3. make student's assignments;
4. list the students;
5. review a student's progress, and;
6. change a student's password.

With the student assignment option, the teacher can list three assignments with beginning and end level for each student in the class. He can see whether a student has completed the three assignments or on which problem level he left off and he can delete completed assignments and add new ones.

With the "Review a Student's Progress" option, the teacher can type in the student's name enabling him to receive information on which assignments the student has done, which problem level he is on, his percentage on each completed assignment, and a graph representing the child's progress on the last ten problem levels he worked on. All the problem levels are used to determine his percentage.

The "Change a Student's Password" option enables the teacher to erase the student's present password and to enter a new one in case he has forgotten his old one or told it to another child.

Besides the "Student Management Page" there is a "Class Management Page" which enables the teacher to:

1. add a class;
2. delete a class;
3. delete all assignments for a class;
4. list the classes;
5. review student progress for a class; and
6. set options for a class.

The "Review Student Progress for a Class" option provides, in alphabetical order, a complete or partial list of all individual student progress as shown in option 5 of the Student Management Page. A print-out of this list may be obtained with either a serial or parallel printer.

With "Set Options for a Class", the teacher can add a "Beat-the-Clock" option to the Addition, Subtraction, Multiplication, and Division diskettes. Each problem is answered against the time of the previous fastest

answer. The teacher can also make the clock tick and/or have a time-up beep sound when a student has failed to beat the clock.

When a student enters his name on the computer, it automatically takes him into the Sequence and generates problems at the level assigned by the teacher. In order to enter the program, he must type his name, his class and his password. The computer verifies the information and then proceeds to the appropriate level. When the assignment is finished or the student presses the "ESC" Key, the computer shows a summary of progress and automatically updates the student's record before returning to the title frame. The student may then begin to work on another assignment or someone new may take his place.

The manual, besides describing all of these options provides special notes to explain the little idiosyncrasies of the program such as the necessity for leaving a space between the whole number and the fraction in mixed numbers. It also describes special keys for special purposes and includes "Problem Level Examples" as an aid for the teacher in making student assignments. If a "Progress Chart" shows a student is having trouble with a certain problem level the examples can be used to determine the type of problems causing the trouble.

COMMENTS: The manual for Milliken's Math Sequence is excellent. It offers an accurate description of the features of the package and provides clear, step by step instructions for the teacher to follow in order to unravel the complexities of the management system and to plan the best program for the student. The clarity of the instructions is enhanced by graphic representations of what the teacher sees on the TV or monitor screen. The section on special keys and special notes for using the Sequence anticipate any problems the teacher or student might have as do comments throughout the program to tell the teacher what to do in situations where he might have difficulties. The section on "Problem Level Examples" is very helpful to the teacher in assigning students to various levels. The graph in the student progress portion of the management system, when used in conjunction with the "Problem Level Examples", provides the teacher with useful information on where a particular student is having difficulties.

Teachers may find the Management System difficult to learn and awkward to use. For one thing, the procedure for entering a student's assignments requires a lot of time. Each student's assignment must be entered separately and in a regular classroom setting with thirty students this would take a great deal of time. It would be very useful if the teacher had the option of entering an assignment that would automatically apply to the whole class. Secondly, teachers may not find the record keeping feature with the option of a hard copy print of the last three assignments particularly useful. Thirdly, teachers may object to the system's

not counting the first incorrect response in determining a student's percentage. Both teachers and students may find this confusing as it is inconsistent with most evaluation practices. Finally, unless one teacher is assigned to initialize the disk for the four other teachers who might be using it, it is possible for each teacher to have access to the others' records.

It takes quite a while for the Management System to be completely understood, but it is fairly easy to work with once the peculiarities and limitations are understood.

Unfortunately, the actual drill and practice portion of the Sequence is not handled with nearly the degree of expertise as the management system and the manual. The quality of the graphics, the reinforcement techniques, and the pace and the drill need improvement.

Low resolution graphics have been used to generate the characters and in some cases, particularly in the operation signs, they are so unclear that a child is not sure what he is being asked to do. Even when there are two "1's" together they can look quite dissimilar. The different colours of characters in the same problem look untidy. Horizontal problems needlessly crowded into the top of the screen adds to the disorganized appearance of the screen.

The reinforcement techniques are also very crude, and interfere with the pace of the drill. If a student enters a correct response, he has to wait until a new screen appears and until a WOW or some other excessively positive comment is spelled out on the screen. Then he has to push the return key again to call upon the next question. If he enters an incorrect answer, an unhappy face appears on the screen or a BOO!, and in order to have another try the student must hit the return key, enter his answer, and hit the return key again. If he enters an incorrect response, he is not, at this point, told that his answer is incorrect. Instead, the number he has entered changes to another number which flashes. The flashing answer is fine when the answer is a 2 or a 5 but if, as in the higher levels, the answer is 94375, the student could become very frustrated trying to study an answer that keeps disappearing and reappearing. After having studied the answer, the student again must hit the return key. This is followed by a pause and and then a face appears and the student must wait until two tears slowly drop from the eyes. If he becomes impatient and hits the return key, the next question sometimes comes up with a NO, NO, NO, before the student has entered an answer.

The face, the BOO's, the OOP's, the WOW's might be more effective if

they were used less frequently and more sincerely. Perhaps a more effective reinforcement technique would be to say, "correct" or "incorrect, John" and reserve a comment like "GREAT" for a point when the student has successfully completed a level and is ready to move up to the next. A less childish approach would make the package more versatile and a Grade eight or nine remedial student would then be able to use it for drill. The advantage of having the student see problem levels rather than grade levels is lost for the older student as soon as he sees that first unhappy face.

In summary then, the Manual and the Management System of Milliken Math Sequences are very well designed and presented. The actual drill and practice would benefit from revision, especially in the quality of the graphics, the reinforcement techniques and the pace of presentation. A further improvement in the package which would take it out of the realm of strictly drill and practice and into the tutorial/dialogue category, would be to provide the option of a HELP key which a student could press to receive instructions on how to do the particular problem or type of problem he is working on. Obviously, this would require a much more complex design and consequently a greater memory requirement.

With some revision based on a careful look at what needs improvement, this could be an excellent aid to the teacher. The appeal of this package is that it is a comprehensive carefully documented sequence of steps and tasks to provide drill and practice in every aspect of basic mathematical operations from Grades 1-6. And this, provided in a compact, attractive package. Milliken is apparently in the process of revising the Sequences and will undoubtedly have identified areas where the material needs improvement.

APPENDIX D

List of Focused Interview Questions

OUTLINE OF FOCUSED INTERVIEW QUESTIONS

1. A. Have you used the JEM Courseware Descriptors?

   B. To what extent did they meet your needs for information on CAI coureware?

2. What do you consider to be the most important features of good quality CAI courseware for use at your grade level?

APPENDIX E

Questionnaire

QUESTIONNAIRE: EVALUATION OF MICROCOMPUTER COURSEWARE

Purpose: The data from this survey is required to determine the kind of information teachers want about commercially available microcomputer courseware. It is expected that this data will enable more effective reviews of programs to be produced, and so help teachers make effective choices when selecting courseware for their students.

The information you provide is considered confidential. A summary of the results will be mailed to any participant interested in the findings.

Before beginning, please provide the following information:

School: _____

Years of teaching experience: _____

Grades taught using microcomputer: _____

1. From the list of courseware provided below, indicate with a check (✓), those which you have used with your students, and judge to be of acceptable quality for classroom use. Indicate with an (X) any program tried with students or considered for use, but rejected as unsuitable.

Mathematics:

(__) HURKLE
(__) TENS
(__) METRIC 21
(__) SPEED DRILL
(__) BAGELS

Language Arts:

(__) TALK
(__) SCRAMBLE WORDS
(__) SPELL
(__) CROSS
(__) PREFIXES
(__) WORDER

Science:

(__) ODELL 1
(__) ODELL 2
(__) URSA

Social Studies:

(__) SUMER
(__) CONTINENTS
(__) STATES

2. The following list of elements has been extracted from courseware reviews prepared for teachers. Please rate these elements according to their importance in helping you select suitable courseware using a scale of one (useless) to ten (extremely important).

____ recommended grade level

____ description of how the student is supposed to interact with the program

____ description of how the student actually interacts with the program

____ limitations of the program

____ strengths of the program

____ reasons for teacher acceptance of program

____ reasons for teacher rejection of program

____ outline of stated objectives of the program

____ assessment of the instructional design

____ description of documentation

____ description of reinforcement provided

____ assessment of the effect of reinforcement on student behaviour

____ assessment of the quality of graphics, animation and sound

____ level of student interest with program

____ degree to which students were able to achieve stated objectives

____ suggestions for improvement of program

____ how to integrate the program with the regular curriculum

____ suggestions for effective use of program

____ teacher rating of program based on classroom trial

3. Using the same scale, rate the following approaches according to their importance in helping you select suitable courseware.

____ recommendations from other teachers

____ personal evaluation through inspection of the program

____ trial use with a group of students

____ JEM courseware descriptors

4. A. Has the pattern of student use of the microcomputer changed since the beginning of the Pilot Project? _____

If so, please indicate the % of microcomputer time your students devoted to the following uses:

	Sept.	June
commercial CAI courseware	____%	____&
teacher prepared courseware	____%	____%
programming activities	____%	____%
games	____%	____%

B. To what extent were students involved in the selection of available courseware?

a. almost always allowed to choose	____	____
b. frequently allowed to choose	____	____
c. sometimes allowed to choose	____	____
d. infrequently allowed to choose	____	____
e. never allowed to choose	____	____

5. Comment on what you consider to be the main limitations of the courseware presently available.

APPENDIX F

Summary of Design Features

SUMMARY OF DESIGN FEATURES

1. The program will run right through without becoming "hung-up" because of unexpected responses.

2. The "escape" directions are repeated at timely intervals throughout the program.

3. When the student is confused, help can be obtained.

4. The student is not trapped in a situation where a repeated incorrect response results in the same question being repeated over and over again.

5. Depending on the complexity or purpose of the program, the branching capabilities of the microcomputer are used when a student obviously shows that some tutoring or further information is required before proceeding.

6. Feedback as to whether the student's response is correct or incorrect, is immediate.

7. Positive reinforcement and encouragement are given intermittently.

8. Reinforcement is positive, appropriate, dignified and <u>not</u> time consuming.

9. Directions are accompanied by useful examples where appropriate.

10. The student can choose to see the directions again.

11. Sound is used only when it is essential.

12. Colour, graphics and animation are used only when they enhance the lesson.

13. Advantage is taken of the interactive capabilties of the microcomputer.

14. Protocols of communication from the user to the computer are logical and unvarying.

15. The student is never left with a blank screen and no indication of what is happening.

16. The program ends with some suitable directions for the student.

17. The program operates at the rate of the person sitting at the keyboard.

18. The material is appropriate for the target grade level in terms of prerequisite basic skills.

19. Documentation is available.

20. The text obeys the strictest rules for punctuation, capitalization, grammar, spelling and usage.

21. Words and lines are spaced for ease of reading.

22. The use of space on the entire screen is effective.

23. Variation in type and organization of textual materials are appropriate for a clear presentation.

24. Students enjoy using the program.

APPENDIX G

Summary List of Features Teachers Consider To Be The Main Limitations of the CAI Courseware Presently Available

SUMMARY LIST

Features Teachers Consider To Be Main Limitations of CAI Courseware Presently Available

(Ranked in descending order based on the number of respondents mentioning the feature on the questionnaire)

Group 1. (Mentioned by four or more of twelve respondents)

Relevance to B.C. Curriculum:

--many of the present materials do not match well

--too American oriented, especially in Social Studies and Science

--not relevant to our environment, needs adapting to B.C.

Availability:

--insufficient amount of CAI courseware is available

--difficult to obtain

--costs are high

Educational Quality:

--do not allow enough for teacher input or modification

--teacher input is required in preparation (many programs appear to be written by technicians rather than educators)

--dwells on computer as tutor, not on student as learner

--too many programs are like workbooks; may limit children's view of what is possible with computer technology

--wanders from the objective

Group 2. (Mentioned by several respondents)

Feedback:

--some programs do not provide enough feedback; should do more than supply correct answer i.e. store results, classify and show problem areas

Reinforcement:

--often inappropriate and overdone

Group 3. (Mentioned by one respondent)

Documentation:

--not well enough documented

Inconsistency

--inconsistencies within the program can be confusing to students i.e. ½ and 1/2 used interchangeably.

APPENDIX H

Summary List of Features Teachers Considered Important Components of Quality CAI Courseware

SUMMARY LIST

Features Teachers Considered Important Components of Quality CAI Courseware

(Grouped in descending order based on number of respondents mentioning the feature)

Group 1. (Mentioned by five of twelve respondents)

--should make use of colour graphics capabilities

--should be relevant to objectives and grade level, enhance and not detract by being too time consuming

Group 2. (Mentioned by two respondents)

Foolproof:

--program should be able to handle incorrect responses appropriately

Documentation:

--should be well documented i.e. tell what the program does, provide a listing and hard copy

Reinforcement:

--positive reinforcement should be provided and be appropriate

Feedback:

--should provide correct answer

--should prompt if correct answer not given on first attempt

Managed:

--should store record of students results

Ease of Use:

--should allow student to enter and exit easily

--present menus rather than catalogue

Range of Difficulty:

--should provide for various levels of difficulty, and match level correctly with student

Group 3. (Mentioned by one respondent)

Accuracy:

--uses good spelling, punctuation and grammar

--content factually correct

Objective:

--program should be pertinent to topic taught

--everything (sound, graphics, colour, etc.) should be relevant and stick to objective

--should be an objective which is difficult or time consuming to achieve with traditional methods

Programming:

--should be made clear with REM statements

Directions:

--should be clear

--should be easy to return to directions

Time:

--should be possible to complete in a fairly short period of time since students of elementary school age have short attention spans

Text:

--should be sharp and readable

Summary:

--a summarizing activity should conclude program

VITA

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COMPARING EVALUATIVE MODELS FOR COMPUTER ASSISTED INSTRUCTION DELIVERED BY MICROCOMPUTER IN B.C. ELEMENTARY SCHOOLS

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