THE DEVELOPMENT AND REFINEMENT OF GUIDELINES FOR THE USE OF COMPUTER ASSISTED INSTRUCTION IN SECONDARY SCHOOLS

by

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THE DEVELOPMENT AND REFINEMENT OF GUIDELINES FOR THE USE OF COMPUTER-ASSISTED INSTRUCTION IN SECONDARY SCHOOLS

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ABSTRACT

THE DEVELOPMENT AND REFINEMENT OF GUIDELINES FOR THE USE OF COMPUTER ASSISTED INSTRUCTION IN SECONDARY SCHOOLS

The purpose of this study was to develop and refine guidelines related to the technical and organizational aspects of using computer assisted instruction (CAI) at the secondary school level.

This study developed from a concern among some educators that the attractiveness of CAI as portrayed in many professional and lay publications may result in the attempt by teachers or school administrators to utilize CAI without fully understanding the technical and organizational implications.

The study proceeded in four stages. First, preliminary guidelines were developed from a review of the literature and other available sources. Second, the preliminary guidelines were subjected to field testing. Third, data were collected and processed from the field tests. Finally, the preliminary guidelines were refined in the light of the data obtained.

The preliminary guidelines were developed from two sources. First, a survey of available literature revealed the "state-of-the-art" of CAI in terms of technical and organizational recommendations. Second, experience gained from an exploratory CAI project conducted by the Chemistry Department at Simon Fraser University was also utilized in the development of the guidelines.

Based upon these preliminary guidelines, CAI activities were initiated in two Secondary schools. Teletype terminals were placed in the two schools, employing the IBM "360" general purpose computer and the "Coursewriter" III CAI language used at Simon Fraser University. One school was located in the urban area of North Vancouver approximately 15 miles from the computer. The other school was located in the Okanagan Valley approximately 300 miles from the computer centre. Initial programs were obtained from university sources or prepared locally to support the secondary school chemistry courses.

Logbook notations and observations were made throughout the one school year study. In addition, the fourteen student programmers, three computing centre personnel, six Chemistry teachers, and twelve student monitors were subjected to interview schedules given by impartial

interviewers. Finally, participating students completed a questionaire survey.

The results suggested that the preliminary guidelines required varying degrees of revision. The areas needing major revisions were those related to terminal type, terminal-computer communication, program development, and student-authoring. On the whole, the refined set of guidelines was not markedly different from the preliminary set.

The refined guidelines are presented as a means of assisting the efforts of those who wish to undertake the use of CAI in schools in the future. However, it is clearly recognized that these guidelines do not approach a definitive stage of refinement and that further developmental studies will be required.

This thesis is dedicated to my family, Donna and Byron.

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CHAPTER I.

THE PROBLEM, BACKGROUND, DEFINITION OF TERMS, AND PLAN OF THE STUDY

> "While the famous chef is still engaged in creating the new dishes it is not safe to let the housewife follow the incomplete cookbook containing imperfected recipies." (Kopstein, 1970)

I. INTRODUCTION

CAI (Computer Assisted Instruction) has recently become a familiar acronym among educational technologists. The professional and lay literature hold high expectations for this mode of instruction as a possible answer to some of the pressures which educators face. Some of these pressures, according to Margolin and Mish (1970), include: first, the demand for education by an ever-widening population, reaching almost from the cradle to the grave; second, conflicting demands for greater specialization and greater general adaptability to the tremendously increased rate of change in the economy, coupled with the need for rapid retraining and more general education; third, the need for more comprehensive education, making the individual more flexible and allowing him to participate more fully in our society; fourth, the pressure to keep pace with rapid social changes and the increases in the mobility and fluidity of

society; and fifth, the pressure for increased efficiency, centralization, and knowledge.

Response to these pressures has produced many educational innovations involving the application of technology. Among these is the use of computers in education. Computer uses include administrative needs such as class scheduling and student-record storing and retrieving. In addition, the computer, itself, is often the object of instruction and many schools have purchased mini computers for their computing science courses.

More recently a major use of the computer in education has emerged in which the computer assists the teaching/learning process by providing students with instructional programs. Known commonly as Computer Assisted Instruction (CAI), this use of the computer appears promising to many educators who are feeling the pressures described above.

II. THE PROBLEM

The general question addressed by this study was the following; "Is it possible to develop technical and organizational guidelines which will minimize difficulties

in using CAI in a real school situation? Furthermore, assuming that this is possible, what useful guidelines can be offered to potential users?"

III. BACKGROUND AND IMPORTANCE OF THE PROBLEM

CAI has been described as an advanced form of programmed instruction placed under the control of a computer. Utilizing the processing and memory capabilites of the computer, CAI may provide sophisticated teaching strategies to several students at a time, each one receiving individual attention via a terminal which may be located a considerable distance from the computer.

There appears to have been considerable experimentation in the use of CAI. An increasing amount of literature gives evidence of this activity.

Within the experimental literature according to Bundy (1968), there appears to be concensus on at least the following ten points. First,it has been reported that students seem to learn at least as well with CAI as with conventional classroom instruction. Second, CAI can provide learning and retention at least equivalent to conventional techniques, in the same amount of time. Third, the computer

instructional program can make logical decisions and adjust to individual student differences with regard to learning sequence, depth, mode of material, and rate of progress. Fourth, the computer can record, store, and manipulate a wide variety of data about the student's progress during instruction. Fifth, the computer can reduce certain kinds of tedious work usually required of the student such as mathematical routines. Sixth, the computer program can integrate and control a wide variety of audio-visual aids in the learning program, for enrichment and motivation. Seventh, time sharing (a number of students using the same computer simultaneously, and perhaps at distances remote from the computer) is within the capabilities of present technology. Eighth, a broad range of courses can be programmed for CAI, particularly in the tutorial mode of instruction. Ninth, the attitude of students toward CAI is generally favourable. And tenth, existing curriculum materials can readily be used in development of CAI courses.

The literature also commonly reports that the advancement of technology is resulting in faster, more powerful computers and that the decreasing per unit cost will soon bring CAI within the financial reach of most schools. For example, Ritzer and Skaperdas (1969) predict that the CAI research they are engaged in at the University

of Illinois' PLATO system will produce a CAI system at a fraction of the present costs.

The literature, however, may be perceived as rather one-sided in that most of what has been written on CAI has been written within the context of educational research. Often funded by special grants, the findings reported usually do not reflect the 'real school' situation and may be, justifiably, open to criticism by pragmatists.

Project REFLECT (Wastler, 1969), for example, was designed to assess the role of CAI in an operational school setting in three Montgomery County schools. The project, however, was financially supported by a US Office of Education Title III grant. This funding included a staff of eleven CAI and curriculum specialists. This level of personnel support is unlikely to be available to typical CAI use in the future.

According to Dettinger (1969), the application of CAI within the framework of the existing school financial structure is very unrealistic, if not impossible. However, recent technological developments might modify this position.

Bundy (1968) felt that "some institutions will be attracted to CAI for reasons of prestige or misguided enthusiasm."(p. 428) With this approach, he stated, they "run a high risk of being quickly disillusioned when they discover the dearth of off-the-shelf CAI programs available, and the time, personnel, and cost required to develop instructional materials and to operate a CAI system." (p. 427)

In addition, it was the investigator's opinion that, with the application of technological innovations such as CAI in a real school situation, there are likely to be many hidden factors which go undetected during the planning stages only to show up in the operational stages. These factors can be costly in terms of money, human resources, and time, as well as leading to frustration and dissention among those involved.

Bundy (1968) summed up the difficulty well:

> "One of the current dangers is that schools will erroneously attempt an involvement with CAI based only on faddism or a sincere but naive understanding of what is involved." (p. 429)

To determine "what is involved" and to minimize the "dangers" were among the purposes of this study. As a

consequence, this study attempts to put forth a set of technical and organizational guidelines.

IV. DEFINITION OF TERMS

1. Author: One who writes a course for computer-assisted instruction and has complete control over the course content. (IBM Author's Guide, 1969.)

2. Computer-Assisted Instruction (CAI): an automated instructional technique in which automatic data processing equipment is used (a) to control the presentation of stimuli to a student, (b) to accept and evaluate the student responses, and (c) based on that interaction, to present further stimuli calculted to shape the student responses in the desired manner; the student uses a terminal directed by computer that may be in the same room or some distance away; the terminal is generally equipped with information display and student response devices. (Good, 1973)

V. DELIMITATION OF THE STUDY

This study did not explore the effectiveness of CAI, nor the attitudes of teachers and students toward CAI as an instructional device. The study examined CAI hardware and software technology and costs only to the extent that this was necessary to the purpose of the study. No attempt was made to determine the cost/effectiveness of CAI. The study was concerned with CAI programs written in the tutorial dialogue mode which were readily available through the Simon University CAI library or generated at the test site.

It is recognized that the study limited its scope to secondary school chemistry students, that the population size was relatively small, and that the field test of guidelines involved only two schools.

VI. PLAN OF THE STUDY

The thesis is organized in the following way: Chapter II reviews the existing literature and presents a set of preliminary guidelines. Chapter III

outlines the procedures used in conducting the field test of the preliminary guidelines. Chapter IV presents the results of the field test and Chapter V applies the results to the preliminary guidelines and presents a refined set of guidelines.

CHAPTER II.

THE REVIEW OF THE LITERATURE AND THE DEVELOPMENT OF PRELIMINARY GUIDELINES

It is recognized that CAI, because of its intrinsic 'assisting' and 'instructing' characteristics, encompasses many facets of educational practice and theory. An examination of the extensive literature in the area of learning, programmed instruction, curriculum development, teaching machines, and so forth, was considered to be beyond the scope of this paper. The available literature was reviewed therefore with the express purpose of arriving at the state-of-the-art recommendations with respect to the technical and organizational aspects of using CAI in public school settings.

This review has been divided into two main categories; a technical review and an organizational review. The technical review is concerned with the recommendations, in light of objectives and financial considerations, of the type of computer, terminal, communication mode, and CAI software. The organizational review is concerned with teaching personnel, student preparation, initial programs, program development, and related administrative concerns.

I. TECHNICAL REVIEW

1. Defining Objectives

Dick, Latta, and Rivers (1970) suggested that the first question to be answered when considering the choice of a CAI system is "what are the system's objectives?" They raised several questions that require an answer before proper decisions can be made relating to hardware, software, personnel, and resources. These were:

> "1. Will the school be involved in developing instructional materials?
>
> 2. Will there be an involvement in research?
>
> 3. Who are the students having access to the system?
>
> 4. Which mode of CAI would be most effective for that student population?
>
> 5. Will CAI be operating within a conventional lock-step school program or an individualized instructional program?
>
> (p.242)

Dick, Latta, and Rivers, failed, however, to offer any answers to these questions except to say that "research" involves possibly more expense because of hardware needs and that program development would require personnel thus adding to the expense.

Haven (1970) described several factors which, taken together, defined a school's need and capacity in a CAI system. The quotation which follows provides a useful perspective on these factors.

> "THE NATURE OF THE SUBJECT MATTER. Is it something that can be presented in a printed format, or must graphic or audio media be employed? A list of subjects and their characteristics will help to determine requirements for input/output media and languages.
>
> INSTRUCTIONAL STRATEGIES. How will the computer be used in the instructional process? Which of the following tasks will the system perform: student problem-solving; tutorial; drill and practice; games and simulation; computer-managed instruction; testing? The application affects requirements for input/output media, language, and responsiveness.
>
> THE AGE AND ABILITY OF THE STUDENTS TO BE SERVED. Can the students read? Can they type? Can they do arithmetic? Can they do algebra? Are there physical handicaps? These factors affect the requirements for input/output, language, and responsiveness.
>
> THE NUMBER OF STUDENTS TO BE SERVED. This number will help determine required throughput (productivity) and storage capacity.
>
> THE DISPERSION OF THE PUPILS TO BE SERVED. Are the students all in the same complex of buildings? Are they in the same town? Dispersion mainly determines the communication link between the input/output terminals and the processing unit.
>
> PREPAREDNESS OF STAFF. How experienced is the school staff in computer programming, teaching with the computer, operating and maintaining computers, etc? Are there persons on the staff who can train others in these areas? Will it be possible to hire a person with the necessary

> training and experience to make up for present deficiencies? The degree to which the staff is self-sufficient will help to determine the amount of outside support required.
>
> THE EXPECTED LONGEVITY OF THE CAI PROJECT. Is this an exploratory program with a very tenuous future or is there a good possibility that CAI will still be in use in, say three or four years? Program longevity has an important bearing on the way in which computer services are acquired, regardless of the nature of the services.
>
> (pp.14-15)

2. The Computer

There are basically two computer systems for use in CAI. One system is a computer configuration totally dedicated to CAI. An example of such a system was used in the Stanford Project (Atkinson and Wilson, 1969). Called the IBM 1500 system, the computer is capable of serving thirty-two terminals almost simultaneously. A similar but much larger system is the "Project PLATO" computer at University of Illinois which can theoretically serve four thousand terminals. (Wong, 1970).

The other system is the multiple access system which utilizes a general purpose computer. The computer, often referred to as a "time sharing system", dedicates a portion of its computing facilities to CAI. Examples of such computing systems are in use at Harvard (Stolurow, 1969) and Simon Fraser University (Lower, 1970). The main difference

between the two systems from this study's point of view is not so much a matter of the technical configuration but of the financial implications associated with each.

A computer system can either be purchased or leased. In the case of the computer being dedicated exclusively to CAI use the computer often resides in the school or at least within the school district. In such a case the relative merits of purchasing or leasing are of considerable significance.

Haven (1970) provides a review of the advantages and disadvantages of purchasing or leasing a computer. He stated that one of the advantages of purchasing or leasing a computer system is that the computer equipment can be matched to the instructional requirements. Furthermore, he stated that one may enjoy flexibility in altering the system to meet changing instructional requirements. He also considered accessibility to the computer itself as particularly desireable in teaching computer science programs.

Haven also listed several disadvantages with the outright purchase or lease of a computer system. First, there is a relatively large capital investment, particularly

purchase arrangements. Second, given rapid changes in computer technology the school may face the problem of obsolescence. Third, in addition to physical space requirements, power, and air-conditioning, the school is faced with personnel and servicing considerations.

In brief, Haven suggested that a school should not buy its own computer if it plans to run the machine only a few hours per day or for a short-term program, because the costs-benefits would be questionable and because it may be difficult to make an adequate recovery of costs through later sale.

Margolin and Misch (1970) suggested that "unless a school is very large, it is usually less expensive to rent service on someone else's computer on a time-sharing basis than to lease or own a computer for the use of the school."

Post (1970) recommended the use of a time-sharing system and in effect recommended against either purchase/lease or the establishment of a computer installation dedicated exclusively to CAI. He stated the following advantages for time sharing. First, time-sharing is the most common mode among experienced school users and

is virtually universal among schools starting out with their first computer installation. Second, the cost of time-sharing makes it ideal for small initial projects. The school's committments are all on a monthly basis; time-sharing suppliers use month-to-month contracts, terminal rentals are typically month-to-month, and telephone-line arrangements are monthly as well. Third, Post felt that a school required only a few weeks to get started with a time-shared CAI system. Fourth, it was considered as a major advantage that no initial capital investment was required and that there should be no difficulty removing terminals and cancelling contracts. Fifth, time-sharing is suited to interactions between student and computer, that is, students are given immediate attention from the computer resulting in a "dialogue". Time sharing systems are designed to respond to short inputs, responses, and questions from the student, rather than being designed for lengthly data-processing jobs.

Post went as far as to suggest the types of time-sharing facilties that a school might utilize. These were colleges/universities, co-operatives, and commercial suggested that the colleges and universities would perhaps be the cheapest sources of computing service.

2. Terminal

The literature indicated that there are basically two types of input/output devices for CAI.(Haven, 1970) One is the teletype terminal which resembles an electric typewriter. The other is a cathode ray tube (CRT) terminal which displays the text material on a screen not unlike a television screen. Table 1. provides a comparison of teletype and cathode ray tube terminals.

TABLE 1.

COMPARISON OF TELETYPE AND CATHODE RAY TUBE TERMINALS

-teletype-	-cathode ray tube-
input: key stroke	key stroke/light pen
output: hard copy typed	visual electronic display
cost: $80-130 per month	$150-300 per month
line connection: hardwired	hardwired
telephone	telephone (may require more than one line into computer)
print rate: 180 wpm	400 wpm
misc: noisy; readily available	quiet; not so available

Table 1. suggests that the main advantage of teletype terminals over cathode ray terminals is the hard copy print out. Hard copy allows the student to take the interactions which he had with the computer for further analysis by himself or with his teacher. This feature would appear to be particularly useful in the area of problem solving. The cathode ray terminal, on the other hand, does not provide a hard copy. The information on the screen is electronically generated and is replaced when new information is received by the terminal. Some cathode ray terminals can be equipped with light pens which enable the student to respond by pointing the light pen at the answer. The Stanford CAI project (Suppes,1969), for example, used cathode ray terminals with light pens for the students in the first to fourth grades.

Another advantage of cathode ray terminals is the speed at which they display informatior on the screen. This becomes a significant factor if much information is to be presented. Drawings, charts, and diagrams, for example, can be displayed much more quickly than on teletype terminals.

O'Neal (1970) suggested that schools should rent not only computer time but also teletype terminals using the

public telephone system as means of data transmission. He further emphasized that the rental approach afforded the flexibility to enlarge or diminish the size of the CAI system according to demand.

3. Terminal-computer Communication

Two common means of connecting the terminal to the computer are through the use of "direct wire" connections or by the use of existing telephone circuitry. According to IBM engineers, the direct wire connection is feasible only if the distance between the terminal and computer is less than one thousand feet. The cost of cable and lost of signal factors become prohibitive beyond this range.

The advantage of the second method, telephone circuitry, is apparent when one considers the possibility of connecting a terminal to a computer from virtually anywhere in the world where telephone communication exists. The apparent disadvantages are the relatively high communication charges and unreliability of telephone circuitry.

4. Computer Assisted Instruction Language

Charles Frye (1968) stated that computer languages fall into four general classifications: (1) conventional compiler languages; (2) adapted conventional compiler languages; (3) interactive computing and display languages; and (4) specially devised instructional authoring languages. Computer Assisted Instruction languages are categorized under class four in this list. In general, these languages include capabilities for building and administering instructional sequences. They monitor the student's activities, collect and store performance records, and then make the information available to authorized persons. Frye listed twenty-two CAI languages at the time of his review. He stated that "the state-of-the-art is changing so rapidly and documentation is so sparse that a fully adequate appraisal of the many languages is impossible." (p.34)

Frye also remarked that "the better the agreement between the design objectives of the language and the application for which it is being used, the easier it will be to learn" (p.44). Frye listed several factors which were considered important in choosing a language. These were: (1) Ease of learning-- does the design of the language and its users agree on its application? (2) Ease of use-- is

the language useable in terms of authoring? The language should have error diagnosis, flexibilty to manipulate materials for the purpose of editing and debugging. (3) Need for record keeping-- is it necessary to have records of student-computer interaction? (4) Language documentation-- is the language sufficiently experienced so that 'bugs' have been removed? (5) Application-- how will the language be used? (6) System support— does the computer service have the necessary hardware and software to support the language?

The literature makes many references to computer reliability. Oettinger (1969) wrote, "The major computer manufacturers now freely admit that they have consistently underestimated the difficulties to be overcome in developing complex systems." (p.187)

> Opler (1968) reinforced this concern when he stated: "The history of the development of computer hardware, software, and applications has been characterized by 1) lateness 2) rescheduling 3) cliff-hanging finales 4) substitution of interim versions for the promised ones 5) the substituion of a "phase 1" goal for the full goal, or 6) the on-time delivery of the promised system in a version whose quality and reliability were too poor to allow system usage." (p.32)

This unreliability manifested itself in Diamond's (1969) study where he reported "CAI systems have a

reputation of unreliability which caused much frustration, leading often to a poor attitude toward CAI." (p.4)

5. Costs

The literature was found to be vague in the area of CAI costs. Silberman (1969) identified four main areas of concern for CAI costs. These were: 1) the computer hardware; 2) terminals; 3) communication; 4) software and support resources.

Kopstein and Seidal (1968) made a comparison between traditional teaching costs and CAI costs. They arrived at a ratio where CAI cost ten times as much as "traditional" teaching. Bitzer and Skaperdas (1969), on the other hand, predicted that the PLATO system at the University of Illinois will provide CAI at the same or less cost than traditional instruction. Oettinger (1969) pessimistically stated, however, that one can easily "perform mathematical trickery to the statistics" (p.190) to make CAI costs look feasible. Duhl (1970) was more direct with his remark about CAI costs. He flatly stated "nothing new or better ever costs less in our society."(p.231) MacDonald (1970) and Silberman (1969) would possibly take exception to Duhl's statement. MacDonald anticipated a reduction of CAI costs

as the hardware technology advanced. Silberman felt that miniaturization of computer circuitry promised to bring the hardware costs down rapidly in the future. MacDonald stated, however, that in spite of anticipated hardware cost reductions, the price of the current hardware has been roughly estimated as only one-fourth the total cost of a school computer system.

Fully aware of the foregoing discussions, Kropp (1970), however, warned "the current obsession about cost benefit and effectiveness might preclude exploring the unique capabilites of the computer for assisting the instructional process."(p.215) He further stated "An equally exasperating aspect of this cost obsession is using 'presentation time' as the criterion measure for judging effectiveness of CAI. Educational achievement seems to be ignored as a relevant criterion. It might be ignored because a dollar value cannot be attached to it, a fact which industrialists discovered during the last few years and educators have known for centuries."(p.215)

Post (1970) stated that there are three distinct monthly costs for the time-sharing user: the computer, the terminal, and the telephone line. He identified two methods by which time-sharing services can charge for computer time.

One method is a variable charge, by which the user need pay only for what he uses. The other method is a flat rate for the month, offering the user "unlimited" service for one price.

Three variable charges were identified by Post. First, there is the "connect time", that is, the time the terminal is connected or "on-line" to the computer regardless of whether the terminal is "active" or not. Second, there is the Central Processing Unit time (CPU), that is, the 'thinking' time required by the computer to execute exchange between the student and the computer. And finally, there is storage, that is, the amount of information storage required by the student.

Furthermore, Post estimated telephone service to be one-fourth to one-half of a school's total monthly CAI costs. Two types of telephone service were cited. First, the use of private or business lines; and second the use of a dedicated line. The cost of the former is the same as for ordinary telephone subscribers. The cost of the latter tends to be a flat rate charge based on the distance between the terminal and the computer.

II. ORGANIZATIONAL GUIDELINES

The organizational guidelines pertain to personnel and organizational factors. Personnel factors are those that will assist administrators, teachers, and students in the use of the CAI system. Organizational factors are those which will aid in making the CAI system accessible to the students.

1. Teaching Personnel

Kropp (1970) stated: "Many innovations having considerably less potential impact than CAI were stillborn because the innovators failed to take into account their probable effects on the host's organization, power structure, roles, sociological and psychological forces, and sources of human satisfactions." (p.208)

MacDonald (1970) warned that administrators considering the implementation of CAI must be prepared to conduct a well-planned program of orientation in advance of its expected use in the classroom. She reflected on the example of Fox Lane Middle School, Balfor, N.Y. where the teachers

were involved in the development of CAI programs but did not use the system because "administrators failed to recognize that the new teaching techniques demanded new patterns of classroom organization for the teacher." (p.118)

Dick, Latta, and Rivers (1970) suggested that, if possible, volunteers should be selected for CAI projects. They felt that nothing could hinder success so much as using reluctant "draftees". The training of volunteers who will be directly involved with the implementation of CAI should include a visit to a school with a CAI system in full operation as well as extensive workshops and training programs. Furthermore, they strongly suggested that administrators, teachers, students, and parents who will be involved with the implementation of CAI should be prepared in advance. They wrote: "If individuals who will be, or who might be, affected by it (CAI) are not properly initiated or introduced to the medium, the entire effort is vulnerable to sabotage." (p.242)

Kropp (1970) added: "CAI development and implementation will proceed hazardously without concomittant changes in the educational structure and the professional roles of virtually all school personnel." (p.208)

There appears to be a concensus in the literature on the effect of CAI on the teacher's role in the classroom. Hansen and Harvey (1970) wrote that teachers must be prepared for a role change. From preliminary studies they observed that in a CAI classroom, the teacher appeared to perform fewer information presentation functions. Because of the immediate feedback features of CAI, the teacher also performed less the corrective role. The teacher became more involved, they reported, in guiding individual students and in promoting discussion.

Hill and Furst (1969) compared the role of the conventional teacher and the role of the CAI teacher by field observations. They reported that compared to a conventional classroom the CAI teacher needs to provide significantly less corrective feedback. Furthermore, they found interchange between teacher and student in a non-CAI class to be directed primarily at the whole class or at individuals within the total class. In contrast the CAI teacher seemed to have not only more interchanges with individual students but a greater variety of kinds of interchange. Also it was reported that the nature of "informing" talks was different. The non-CAI teacher mainly provided information about content. The CAI teacher provided information about learning procedures. This

appeared to be in agreement with the observed types of questions CAI students were asking; namely processing questions and not necessarily subject matter questions. It was further reported by CAI teachers that CAI students could be left entirely on their own more often than these students in a conventional classroom.

The foregoing literature suggests that CAI has a definite impact on the role of the teacher. The literature fails, however, to suggest direct means of achieving this change in role. Furthermore, the literature fails to discriminate the different levels of CAI involvement which would have a direct bearing on the degree of role change the teacher should undertake.

Fitzgibbon and Grate (1970) commented that,

> "One of the biggest handicaps to moving ahead in the use of CAI and the creative application of computers in the classroom is the adherence to traditions, the need for close and continuous relationship between child and teacher, the teacher as the sole presenter of course content, and "teaching is an art." As long as these concepts dominate the educational scene, at least within the confines of the classroom, it is questionable that efficient and effective new methods of teaching will penetrate very deeply into the mainstream of education in this country." (p.921)

In view of this possible resistance to change, O'Neal's (1970) findings may be appropriate. He reported that initially it would be wise to build up local expertise in CAI application where possible by utilizing readily available equipment. Once teachers had learned to use the system, it was found that most of the threat was removed and that resistance turned into support.

Considering behavioral change in teaching personnel generally, Watson (1967) wrote that resistance to change depends on several factors. These were:

A. Who brings the change?

1. Resistance will be less if administrators, teachers, board members, and community leaders feel that the project is their own--not one devised and operated by outsiders.

2. Resistance will be less if the project clearly has wholehearted support from top officials of the system.

B. What kind of change?

3. Resistance will be less if participants see the change as reducing rather than increasing their present burdens.

4. Resistance will be less if the project accords with values and ideals which have long been acknowledged by participants.

5. Resistance will be less if the program offers the kind of new experience which interests participants.

6. Resistance will be less if participants feel that their autonomy and their security is not threatened.

C. Procedures in instituting change.

7. Resistance will be less if participants have joined in diagnostic efforts leading them to agree on the basic problem and to feel its importance.

8. Resistance will be less if the project is adopted by consensual group decision.

9. Resistance will be reduced if proponents are able to emphathize with opponents, to recognize valid objections and to take steps to relieve unnecessary fears.

10. Resistance will be reduced if it is recognized that innovations are likely to be misunderstood and misinterpreted, and if provision is made for feedback of perceptions of the project and for further clarification as needed.

11. Resistance will be reduced if participants experience acceptance support, trust, and confidence in their relations with one another.

12. Resistance will be reduced if the project is kept open to revision and reconsideration if experience indicates that changes would be desirable.

D. Climate for change

13. Readiness for change gradually becomes a characteristic of certain individuals, groups, organizations, and civilizations. They no longer look nostalgically at a Golden Age in the past but anticipate their Utopia in days to come. The spontaneity of youth is cherished and innovations are protected until they have had a chance to establish their worth. The ideal is more and more seen as possible. (p.22-23)

Trow (1963) suggested that the objectives of the use of an innovative technique should be defined by the teachers.

He felt that this would remove some of the threat or resistance.

2. STUDENTS

Little information could be found relating to secondary student preparation for CAI. Perhaps the ease in operation of the CAI system from the student's point of view may have contributed to this lack of information.

Long, Murphy, and Wengart (1968) reported that 88% of a group of 138 students (89 high school, 49 college) using CAI to learn about the theories of data processing found CAI enjoyable. Nine per cent felt it was monotonous, mechanical or impersonal. One percent found their concentration adversely affected by difficulties encountered in operating the terminal.

Mathis, Smith and Hansen (1970) indicated that lack of typing knowledge did not cause a negative attitude toward CAI. Bitzer and Boudreaux (1969), however, reported that knowledge of a standard typewriter keyboard enabled the students to work more rapidly.

The Chemistry exploratory project at Simon Fraser University utilized a CAI program which introduced the student to the function and procedure of CAI. (Wong, 1968) This program appeared to be very successful not only in teaching students the basics of CAI, but also in developing an initial positive attitude toward CAI.

3. CAI LANGUAGES

The intent of this study was to utilize CAI in the "tutorial mode" of instruction. It may provide a useful perspective if a description of the main categories of CAI use is given.

According to Post (1970) the use of computers in the classroom falls into five main categories. First, he identified the use of CAI as a drill-master. Under the control of a previously prepared program, the computer will exercise the student in mathematical skills. Second, CAI may be used as a desk calculator. Under the control of a previously prepared program, the computer will perform tedious calculations to expedite the student's progress through mathematical operations. Third, CAI may be used as a simulator. Under the control of a previously prepared program, the computer will simulate in the classroom "real

world" situations, or theoretical or abstract models. Fourth, Post identified the use of CAI as a tutor. In this mode, the computer will engage the student in a question-and-answer dialogue designed to aid him in the formation of concepts and development of skills. Fifth, CAI may be used as a problem solver. The computer may serve as a sophisticated tool to be programmed by the student as an exercise in algorithmic thinking.

As mentioned previously, It was the intention of this study to utilize CAI in the fourth mode, namely tutor or tutorial dialogue. The tutorial mode lends itself to the teaching of concepts which, in view of the maturity of the students and the subject matter, appears to be appropriate for this study.

Mathis, Smith, and Hansen (1970) suggested that "initial programs which are bug-free, relevant and allows attitudes toward CAI at the outset." (p.46)

These authors further reported that among college students, the magnitude of attitude change was dependent on the kind of initial CAI experience they had. Students who had familiar and relevant CAI programs, and made few errors

while undertaking them, showed the greatest increase in positive attitudes to CAI.

Diamond (1969) reported that negative student attitudes toward CAI resulted from boredom and from program "bugs", or design faults.

Kropp (1970) stated that the absence of instructional software is a critical limitation. He criticized the development of CAI as being "one-sided" with the emphasis on hardware. He wrote: "Educators from public schools and higher education and content specialists must be brought into the mainstream of CAI development because their abilities are precisely the ones industrial participants seem to lack."(p.215.) He further criticized the existing CAI languages as "very primitive" and severely limit the quality and sophistication of instructional materials. Perhaps this concern prompted Duhl (1970) to state that "the most expensive and obviously problematic issue is software." (p.232)

Two main indexes of prepared CAI programs were identified. These were "Entelek" (1969) and "The Index of Computer Assisted Instruction" (Lekan, 1969).

DEVELOPMENT OF CAI PROGRAMS

From his findings in the Kansas City CAI project, O'Neal (1970) indicated that teachers felt strongly that individual teachers should be involved in CAI curriculum development.

This finding may give some clue to why Duncan and Slack (1969) frequently observed that CAI was not effectively used in many schools because the CAI curriculum was generally out of phase with that of the school in general.

Suppes, Jarman, and Brian, (1968), however, offered a sobering statistic. He estimated that for every hour of CAI instruction at the student terminal, over 100 hours of author programing has taken place. To overcome this awesome ratio, the SFU Chemistry project employed undergraduate and graduate students to assist professors developing CAI curriculum by performing the time-consuming tasks of actual program entry and of de-bugging.

ADMINISTRATION

Very little was gleaned from the literature regarding practical suggestions such as location of terminals in

schools, size of area for CAI terminals, accessibility, etc. Most likely the use of common sense is assumed for these concerns. It was interesting to note that Duncan and Slack (1970) reported that the teletype terminal is at least as noisey as an electric typewriter and consequently, may be very disturbing. This comment appears to give basis to Post's (1970) suggestion that the terminal should be housed in a separate room with a door.

O'Neal (1969) suggested that the use of monitors in the terminal area would not only be beneficial to students who may require assistance in the operation of the terminal and the CAI system, but beneficial to the organization of the terminal area. The monitors would police the area to "prevent the monopolizing of the terminals by over-zealous students." (p.10)

O'Neal referred to the flexible schedule school program as an ideal timetable for the effective use of CAI. Cavanaugh (1971) wrote that modular scheduling provided greater time flexibilty for both teachers and students. In particular, its use resulted in more student free time and increased student use of resource facilities.

Post (1970) stated that the ideal number of terminals is in the ratio of one terminal per five students. This, of course, appears to be unrealistic for most schools because of terminal and line costs.

THE DEVELOPMENT OF PRELIMINARY GUIDELINES

The literature states that the objectives of the CAI system should be clearly defined. The objectives of the CAI system in this study were therefore: (1) The system will provide tutorial dialogue CAI programs in Chemistry in the area of remedial and enrichment learning. (2) Programs are intended for secondary chemistry students in grade 11 and 12. 3) The system will provide printed copy of computer-student interactions. (4) The sponsors of the project will encourage development of CAI programs. (6) The system must be capable of utilization by an inexperienced staff.

In view of the objectives defined for the use of CAI in this study and in light of the review of the literature, the following set of initial guidelines was developed for this project.

I. TECHNICAL GUIDELINES

(A) The Computer

Guideline 1." Rent computing service on a time-sharing basis from a general purpose computing facility." (Haven, 1970; Margolin and Misch, 1970; Post, 1969.)

(B) The Terminal

Guideline 2. "Rent teletype terminals that can be easily connected to the computer." (O'Neal, 1970.)

(C) Terminal-Computer Communications

Guideline 3. "Rent telephone data service from the existing public telephone network to provide a communication link between terminal and computer."(O'Neal, 1970)

(D) The CAI Language

Guideline 4. "Employ a well developed and reliable instructional authoring language." (Frye, 1968; Opler, 1968; Diamond, 1969.)

II. ORGANIZATIONAL GUIDELINES

(A) Teacher Preparation

Guideline 5. "Teachers should be made fully aware of the concepts, capabilities, and limitations of CAI by means of introductory workshops." (Kropp, 1970; MacDonald, 1970; Dick, Latta, and Rivers, 1970; Hansen and Harvey, 1970; Hill and Furst, 1969; Fitzgibbon and Grate, 1970; O'Neal, 1970; Watson, 1967.)

Guideline 6. "An enthusiastic teacher volunteer should be chosen to perform local coordinating duties and liason duties." (O'Neal, 1970.)

Guideline 7. "Teachers should be involved in defining the objectives of the CAI system in their particular school." (Trow, 1963)

(B) Student Preparation

Guideline 8. "No necessary preparation is required except for instructions on how to use the CAI system. A CAI course on the use of the CAI system should suffice." (Lewer, 1970)

(C) Initial CAI Programs

Guideline 9. "A search through indexes of CAI course materials should be made for possible sources of courses." (Lekan, 1969; "Entelek", 1969; Kropp, 1970.)

Guideline 10. "Initial programs should be relevant and "bug-free" and should minimize opportunities for student error." (Mathis, Smith and Hansen, date; Diamond, 1969.)

(D) Program Development

Guideline 11. "Teachers should be involved in developing CAI programs for their curriculum needs." (O'Neal, 1970; Duncan and Slack, 1969.)

Guideline 12. "Teachers and senior level students should join together as an authoring team whereby the teacher provides the curriculum material and teaching/learning strategy and the student assists by performing the actual CAI programming and debugging." (SFU Chemistry project, 1970; Suppes, 1968.)

(E) Administrative Concerns

Guideline 13. "The terminal(s) should be located in a room with the following features. First, the room should be easily accessible to student users throughout the school day. Second, the room should be located in an area where the noise from the terminal will not interfere with surrounding teaching areas. Third, the room should be sufficiently large to include not only the terminal and chair, but also worktables, resource materials, and a table and chair for the student monitor." '(O'Neal, 1970; Duncan and Slack, 1970)

Guideline 14. "The schools should be on a program such as flexible modular scheduling which allows students access to the terminal throughout the day." (O'Neal, 1970; Cavanaugh, 1971.)

Guideline 15. "Volunteer students should be recruited to perform monitor duties wherein they assist students with CAI routines, maintain the terminal room in good order, note any program difficulties, and "register" students for CAI courses." (O'Neal, 1970.)

This study set forth as its goal the development and refinement of guidelines for the use of CAI in the secondary school. The foregoing preliminary set of guidelines was developed from the reviewed literature and with a view to the intended use of the CAI system under consideration. Though listed numerically as distinct guidelines, it was recognized that the guidelines were not independent of each other. For the purpose of this study, however, the guidelines were treated separately, although their interdependence is discussed in Chapter Six.

CHAPTER III.

APPLICATION OF PRELIMINARY GUIDELINES AND DATA GATHERING PROCEDURE

This chapter outlines the procedure by which the preliminary guidelines were applied to the real school situation to assess their appropriateness. The selection of schools and the application of the preliminary guidelines in the schools are described. The chapter concludes with a discussion of the data gathering procedures.

I. THE SELECTION OF SCHOOLS

Two senior secondary schools in B.C. were sought for the field trial. It was considered desirable that one school be within the Greater Vancouver area and the other school be located somewhere in the interior of B.C. in order to provide an adequate assessment of the problems of a CAI facility served by a central computer which was a considerable distance away. Resources did not permit involvement of more than two schools.

The schools selected were determined by requirements of the guidelines themselves. In particular, the following criteria were used. First, the school board and

administration had to be supportive of the project. Second, the population size of the chemistry students in each school had to be of sufficient size to justify the use of CAI and to provide sufficient student participants. Third, the schools had to be willing to commit physical space for a terminal area. Fourth, the schools had to provide released time for a teacher to become a local CAI "coordinator." Fifth, the school program and schedule had to allow adequate CAI utilization by the students. Sixth, the teaching staff should be in support of the concept of teacher-student authoring teams for CAI program development.

Of the several senior secondary schools that were considered for the project, the two schools which best met the criteria were Handsworth Secondary School and Kelowna Secondary School.

Handsworth School is located in North Vancouver approximately fifteen miles from the computer. Situated in an urban middle class community, the school offers both junior and senior secondary education to its 1100 students. The Chemistry program involved three teachers serving approximately 100 students in Chem 11 and Chem 12.

Kelowna Sr. Secondary is located approximately 300 miles from the university in the town of Kelowna. One of two senior secondary schools in the Kelowna School District, it serves a student population of 2400 day and evening students. The Chemistry program involved three teachers serving approximately 90 Chem 11 and Chem 12 students.

II. TECHNICAL RESOURCES EMPLOYED IN THE STUDY

1. Computer

The general purpose computer at Simon Fraser University, Burnaby, B.C. was used for this study. An IBM 360 Model 45, it processed on a time-shared basis the academic, administrative, and instructional needs of the university community. Its computing and storage facilities were of sufficient size to have a surplus capacity to meet the needs of this project.

2. Terminal

The terminals used in this study were IBM 2741 teletype terminals. Readily available and relatively inexpensive ($100/ month rental approximately) these terminals were chosen because they were easily connected to the computer.

One terminal was placed in Kelowna Secondary School and two were placed in Handsworth Secondary School.

3. Terminal-Computer Communication

The telephone service of the B.C. Telephone Company was rented as the communication link between the terminal and the computer. "Dedicated" lines costing approximately $2.50 per mile per month were specified. Two data couplers (one for the terminal end, and one for the computer end) were required on each line at a rental cost of $35.00 per month per coupler. It was this communication cost which was the major limitation on the number of school sites and number of terminals used in this study. (See Appendix A for cost as quoted by B.C. Telephone Co.)

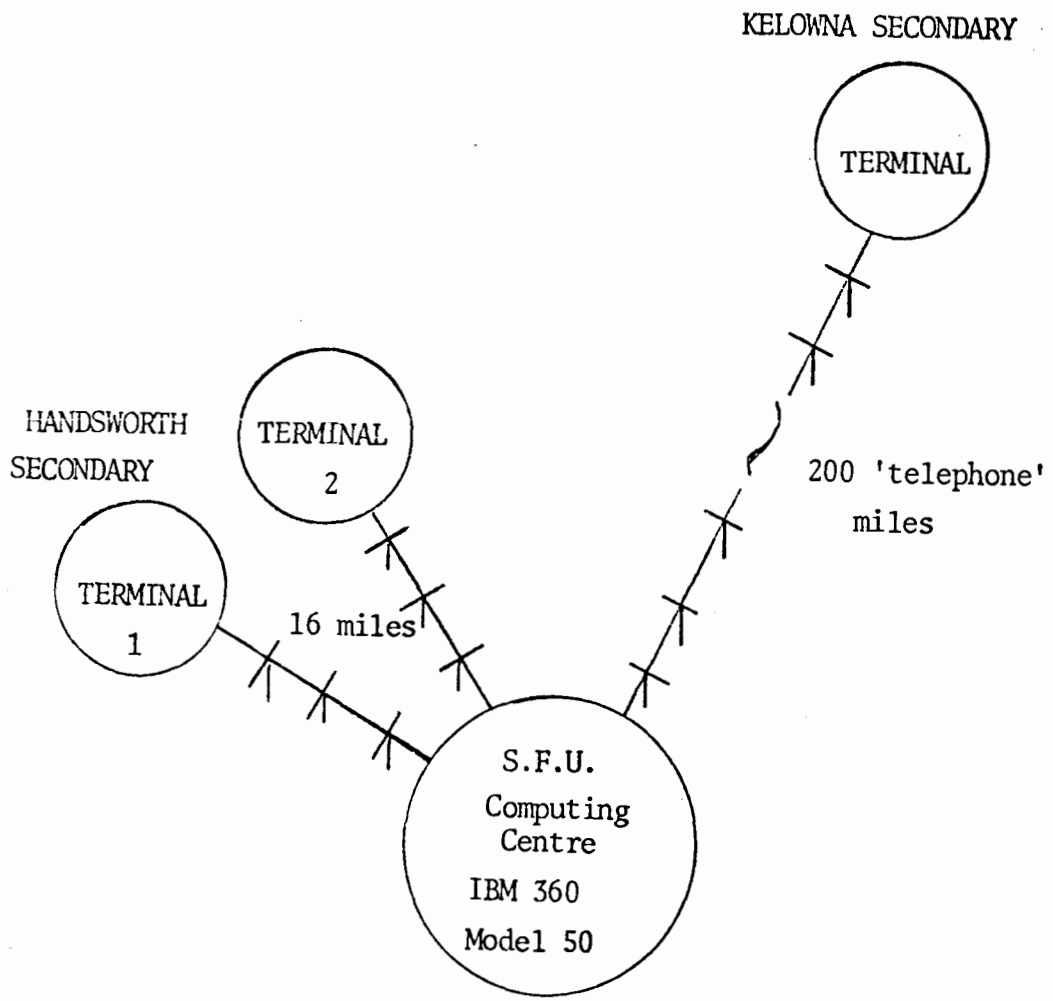
4. CAI Language

The CAI language that was in use by the SFU Chemistry exploratory project was made available for the study. Known as "Coursewriter III, Version I," the IBM developed language was considered one of the best CAI languages at that time.

Diagram 1 illustrates the computer-terminal configuration. A more complete description of all the preceeding technical resources is available in Appendix B.

Diagram 1.

Schematic of Secondary School Terminals and Simon Fraser University Computer Centre.



III. HUMAN AND ADMINISTRATIVE RESOURCES

1. Teaching Personnel

A one day workshop was given in each school according to the guideline specifications. Teachers other than chemistry teachers were also invited to participate in the workshop. No terminals were available in the field at the time the workshops were given . However, teachers were given an open invitation to SFU for a 'hands-on' experience with the Chemistry system. A motion picture film of the SFU Chemistry CAI project was presented along with overhead transparencies outlining the concepts of CAI. Coursewriter manuals were issued and simulated programmings were performed by the participants. Upon gaining insights into CAI the teachers were asked how CAI might best be used in their school. An unanimous decision on the part of both schools indicated that the teachers perceived CAI as a learning aid and that it would be used voluntarily by both teachers and students.

Local CAI coordinators were identified at both schools. The Handsworth coordinator was a Chemistry teacher and was given the equivalent of a half-day per week to perform his duties. The Kelowna coordinator was a Mathematics teacher

and was given one extra spare period per block for his duties.

2. Students

Students were advised via classroom announcements that CAI was available on a voluntary basis to assist them with their studies in chemistry. Teachers also recommended CAI to students and gave them assignments on it in some cases. The "INTRO" program, used with the SFU students to provide instructions on how to use the CAI system, was also made available to the secondary students.

3. Initial Programs

Six chemistry programs were made available of which three were obtained from the SFU Chemistry Department CAI library. The other three programs were developed by two Handsworth teachers over the summer break preceding the field study. The SFU programs were selected for the appropriateness of their content and their reliability. Appendix (C) lists the names of each program, a brief description of its content, and its source.

4. Program Development

Eight Handsworth grade 11 and 12 students volunteered to assist teachers in developing CAI programs. The three Handsworth Chemistry teachers responded to the student-authoring team approach and developed programs covering aspects of science.

Three Kelowna teachers and six senior students formed programming teams. Programs were attempted in subjects ranging from biology to english drama. However, only the biology program was completed. Appendix (D) lists the student-teacher authored programs and the school where they were authored.

5. Administration

The Handsworth terminal area was a partitioned off area of the science lab preparation room. Considered centrally located and accessible to the students, the room was of sufficient size to house the two terminals and work tables. (See schematic diagram of school and location of terminals, Appendix E.)

The Kelowna terminal area was a corner of a book storage room across the hall from the chemistry labs. Because of the books, the room normally remained locked. The key was available from the school office to authorized persons (teachers, authors, monitors). (See schematic diagram of school and location of terminal, Appendix F.)

Handsworth ran on a flexible modular scheduled program whereas Kelowna was on a semester/block system. In both cases, students were told to use the CAI system on a first come basis but a limit of one hour per student session was imposed.

Many students volunteered for monitor duties. At Handsworth, the twelve monitors consisted mainly of grade eight students. Kelowna's ten monitors came from grades ten and eleven. A schedule was posted at each site to ensure monitor coverage at all possible times.

III. DATA GATHERING PROCEDURES

Several methods were used for the gathering of data. These included analysis of computer record print-outs, interviews, questionaires, and observations.

1. Computer Data.

The Coursewriter language had several built-in features which enabled the investigator to obtain data on the status of CAI use. Under the "monitor mode," information on who was using CAI, what courses were in use, and on the status of terminals in each location was readily obtained by typing in the command "line status all". Typing in simply 'lines' produced information on the number of available lines and on the user's status for each active line.

Another command listed the status of a particular CAI course. The list included the student's name, user's number, the date student was first registered, the date the student last used the course, the elapsed time on the course by that student and the last segment of the course completed. See Appendix (G) for examples of both "student status" and "line status" print-outs.

2. Logbook and Observations.

A daily log was kept by this investigator on the progress and problems of the project. In addition, Log books were placed at each terminal site in which student monitors were asked to record CAI "crashes" and student reaction to the crashes, and any other notable events.

Observations were made throughout the nine months during frequent visits to the schools. Observations were recorded in a notebook.

The objectives of these observations were to note activities at terminal site and apparent accessibility of CAI. Also, the students' ability to use the terminal for sign-on, sign-off, program access, and response procedures were recorded. Any comments offered by students, monitors, and teachers were also noted. Unobtrusive observations were also made during these visits.

3. Interview Schedules.

Interview schedules were designed for teachers, administrators, program authors, student monitors, and computing center personnel. See Appendix (H) for examples of each interview schedule. In all but the interviews with computing center personnel interviewers were employed who were not involved in the project. Interviews were recorded on audio tape and were later transcribed.

The objective of the teacher interviews was to gain insight into the teachers' perception of the usefulness of the CAI workshop and to seek suggestions on how to improve

the workshop. Other purposes for the interview were to determine the value of other guidelines such as that related to the student-teacher authoring team, accessibility of the terminal area, effectiveness of monitors, initial programs, and student preparation.

The objective of interviews with administrators was similar to those for the teachers. In addition, the financial feasibility of CAI based on the best estimated cost of the CAI system at that time was posed to the administrators for a response.

The objectives of the interviews with program authors was to determine the authors' perception of the usefulness of such a team approach to program development and the ease of handling the CAI language.

The purpose of the interviews with student monitors was to gather insight into the function of the monitors and to determine the monitors' perception of the value of some of the specified guidelines.

Computing Centre personnel were interviewed with the purpose of obtaining feedback on the technical specifications used in this study.

4. Questionnaire Survey.

A questionnaire was issued via the classroom teacher to all students who had used at least one Chemistry CAI course during the school year. The purpose of the questionaire was to gather information pertaining to the guidelines such as introductory programs, student preparation, accessibility of the system, and so on. Students entered their responses anonymously on "mark sense" cards and placed the completed cards in a box provided. The cards were machine scored by an optical scanner which provided a frequency count for each item. (See Appendix I for questionnaire.)

CHAPTER IV

RESULTS

For the purpose of organization, the results presented in this chapter are listed under the guideline headings and subheadings listed in Chapter II.

Because of the number of different data gathering procedures used in this study, it may be useful at this point to briefly review the procedures. First, interview schedules were devised for teachers, administrators, student authors, student monitors, and computing centre personnel. These interviews were given by an impartial interviewer and tape recorded. Upon transcription, the interviewee's responses were categorized as positive, negative, or indifferent (neutral). (See Appendix J for sample interview schedules and summary of results.)

Second, computer-use data was obtained directly from the computer system. A 'users' profile', which listed the CAI users at the time the information was requested, was obtained as frequently as possible throughout the project. Also CAI course utilization records, stored automatically in the computer, were recalled and analyzed. These records

provided data on individual student use of a particular CAI course as well as an overall use of the CAI system. (See Appendix K for summary of computer record analysis results.)

Third, log book entries and observations of noteworthy events were made throughout the project by the author. (See Appendix L for example of records and summarized listing of noteworthy events.)

Fourth, a questionaire was developed and administered to students who had used the CAI system during the project period. A difficulty arose in administering the questionaire, however, that was not anticipated. The questionaire sampled approximately 80% of the Kelowna students whereas only approximately 10% of the Handworth students were sampled. The reason for the poor sample population at Handworth was that many of the students were dismissed for the summer break one week earlier than normally scheduled. Only students returning to write final examinations were available for questionaire sampling. Thus the questionaire data reflects mainly Kelowna student responses. The reader should take into consideration the poor sampling of Handsworth students in the questionaire data analysis. (Appendix M shows results of questionnaire.)

Each guideline is now considered in the light of data obtained from these four sources.

I. TECHNICAL GUIDELINES

A. The Computer

Guideline 1. "Rent computing service on a time-sharing basis from a general purpose computing facility."

a) Data from Logbook and Observations

This guideline was based on ecconomics. The use of a general purpose computer on a rental basis would require no capital expenditure and long term committment on the part of the school. Log book data and the author's observations supported this rationale. At no time throughout the use the the computing facilities by the schools was there a necessity for the school district to commit capital funds. Furthermore, when Kelowna wished to terminate the use of their terminal at the end of the project, there were virtually no difficulties associated with this action such as having to sell the system and/or dismiss personnel that would normally occur with a purchased/leased system.

b) Data from Interviews

The four administrators, Handsworth's Principal and Administrative Assistant, and Kelowna's Principal and Vice Principal, agreed unanimously with the principle of renting computing facilities. The Administrative Assistant at Handsworth remarked how surprised he was at the ease by which a computer "hook-up" was obtained.

The Kelowna Principal stated that the distance between the school and the computer normally was not an issue. However, he felt that during the early periods of the project when the CAI system 'crashed', his school felt rather helpless and ill-informed about the state of the system. He further remarked that though the pictures of the computer and the computing centre were useful, it would have been desireable to have had a tour of the computing facilities for interested teachers and students. The distance factor, however, made this an unlikely possibility.

Based on the best estimate obtainable from the Computing Centre, the cost of computing time was $7.00 to $10.00 per day per terminal which was considered within reason by all the administrators interviewed. This cost was

based on the estimate of 30 seconds of computing time is used per hour of terminal use. (Tinker, 1969) On a six hour day, the computing time used, therefore, is three minutes. The cost of computing is estimated between $150.00 to $200.00 per hour. Therefore, the cost per terminal per day is between $7.00 to $10.00.

Computing Centre personnel stated that no technical difficulites were encountered with the remote terminal hookups and that this procedure was considered routine.

Six of the eight Handsworth student authors interviewed were not concerned with the fact that the computer was some distance away. Two of the eight remarked that it would be desireable to have the computer immediately accessible in order to learn more about the computer.

All six of the Kelowna student authors were not concerned about the distance between the school and the computer.

It would appear from the foregoing that the use of a general purpose computing facility was considered an acceptable means of obtaining computing service and that no major objections or difficulties were encountered.

B. The Terminal.

Guideline 2. "Rent teletype terminals that can be easily connected to the computer."

Similar to the rationale for the rental of computer service, the renting of terminals likewise requires no long term capital commitments. The specification of a teletype terminal was based on the need for printed copies of student-terminal interactions for the purpose of review and consultation.

a) Data from Logbook and Observations

There was virtually no difficulty in obtaining a terminal and connecting it to the computer. The ease of terminal installation was exemplified by the installation of the second terminal at Handsworth school. The terminal was ordered from IBM and was actually operating at Handsworth within one week.

Observations made supported Bitzer's (1969) observations that students with a knowlegde of typing would proceed more quickly through the CAI course than students who lacked the skill.

b) Data from Interviews

Both Handsworth and Kelowna teachers were unanimously in favour of the "hard-copy" printouts. One Handsworth teacher stated, however, that he felt that the terminal printed at too slow a rate. He made the observation that the 'tutorial dialogue' mode of CAI is based on the presentation of text material upon which the student is requested to answer questions. Because of the text materials, the terminal spent a considerable amount of time printing at a rate at least one half that of the average student reading rate.

All monitors reported that, on the whole, students had no difficulty with typing their responses on the terminals. One monitor made the suggestion that the need for typing skill could be minimized by simplifying required responses to single character notations. For example he suggested that students be asked to type the letter 'Y' for 'YES' and 'N' for 'NO'.

Cost of terminal rental was given to be approximately $100.00 per month. This cost was considered reasonable and manageable by the four administrators.

Based on the foregoing discussion, it would appear that no major disagreement with the use of teletype terminals could be found. However, some clear disadvantages of teletype terminals were uncovered.

C. Terminal-computer commnication

Guideline 3. "Rent telephone service from the existing public telephone network to provide communication link between terminal and computer."

a) Data from Logbook and Observations

According to The B.C. Telephone Company the procedures used in this study were considered routine. Thus the installation and utilization of the telephone system proceded uneventfully during the study period.

The telephone lines provided were "dedicated" lines in which the leasee pays a flat rate per mile per month. This study was quoted a rate of $2.50 per mile per month. The monthly communications cost to Handsworth (including data sets) was $110.00. See Appendix A for letter from Mr. Watt, B.C. Telephone Company, to Dr. John Ellis, "Project Director."

The monthly cost to Kelowna was $515.00. This included the two data sets plus two "drop charges" which were necessary because of the long distance transmission. The foregoing monthly charges do not include the "one-time-only" service charge of $60.00 per installation.

b) Data from Interviews

The administrators at the respective schools were questioned as to whether or not they considered the monthly charges as reasonable. Handsworth administrators felt that these costs were very high, however, they felt that the school district would consider the support of one terminal at their school. Kelowna administrators, on the other hand, felt that the costs were totally unsupportable by their school district.

It would appear that the recommendation to use existing telephone service for communication between the terminal and the computer was appropriate provided that the distance covered is small. The reason that Handsworth was able to continue to use CAI following the termination of the externally supported portion of the project and that Kelowna could not was apparently due to this major difference in communications costs.

D) The CAI Language

Guideline 4. "Employ a well developed and reliable instructional authoring language."

The language used in this study was the CAI language that was currently being used by the SFU Computing Centre to support the CAI needs of the Chemistry Department at the University. According to Computing Centre personnel, the language, Coursewriter III Version I, was considered highly developed and well supported by the developers, namely, IBM.

a) Data from Logbook and Observations

Log book data revealed that Coursewriter III Version I (CWIII vsI) was unreliable in actual use. On the average, the CWIII vsI 'crashed' three times per day from unexplained causes. IBM personnel were assigned to solve the difficulties but no solution was found. A newer version of the language, Version II, was therefore implemented. Testing of CWIII vsII began in mid November and it was fully operational by the end of December. Conversion of programs from CWIII vsI to CWIII vsII then had to be done. CWIII vsII was found to be reliable and the project continued to the end using that language.

A noteworthy "memo" was issued at the beginning of the month of November which underscored the difficulties encountered with CWIII VSI. The computing centre stated that should CWIII VSI "crash" between the hours of 2 pm and 6 pm, the language would not be reinstated until 6 pm of that day. Apparently, the frequent number of crashes and restarts of the CAI system resulted in a significant loss of overall university computing time. Each time CAI had to be reinstated, other facilities in the time-sharing system were held up. See Appendix N for memo.

b) Data from Interviews

Teacher interviews reiterated the difficulties observed during the first term. All teachers interviewed felt that reliability of the CAI system was one of the most important factors in student use or non-use. Kelowna teachers felt that the unreliability of the system coupled with the lack of communications between the school and the computing centre regarding the status of the CAI system resulted in very low use of the system during the first term. One teacher felt that the CAI project never really got started until the second term. Another Kelowna teacher stated that he initially wanted to use CAI in his Chemistry course but had to abandon the idea because of the unreliability of the

system. Likewise, Handsworth teachers appeared to be equally frustrated.

On the question of ease of use, the student authors were all in agreement that the CWIII language was easy to learn and use. Two of the Handsworth student authors stated that the CAI course on how to author was not adequate. The other six authors felt that the course was adequate as an introduction. Kelowna student authors were adamant about the lack of programming assistance. They found it difficult to obtain programming assistance because of the distance factor.

It would appear from the foregoing discussion, that the guideline specifying a reliable CAI language is particularly important in terms of student and teacher usage. Furthermore, it can be seen that the CAI language used in this study was not as reliable as claimed. This unexpected unreliability appears to have had negative effects on the initial phase of the study.

II. ORGANIZATIONAL GUIDELINES

A. Teaching Personnel

Guideline 5. "Teachers should be made fully aware of the concepts, capabilities, and limitations of CAI by means of introductory workshops."

a) Data from Interviews

All six Chemistry teachers and the four administrators agreed unanimously with the need for workshops to prepare teachers in the use of CAI. Two Handsworth teachers and one Kelowna teacher felt that the one day workshops conducted in this study were not adequate to enable most teachers to grasp the concepts of CAI. They suggested that a series of workshops throughout the school terms would have been a better approach to inservice. Teachers from each school made the suggestion that the workshop should have been conducted with an operating CAI terminal. They felt that seeing and using a terminal would have aided them to understand the concepts of CAI. In the same vein, the Principal of the Kelowna school stated that the workshop should have been conducted at a location where there was a terminal in operation such as at Simon Fraser University.

It would appear that the guideline regarding in-service workshops for teachers using CAI was appropriate. The criticisms made by the workshop participants were not of the guideline, but of the method by which this study implimented the guideline. Insufficient time spent in inservice education was the main criticism. Perhaps this guideline should specify a complete program of inservice workshops.

Guideline 6. "An enthusiastic teacher volunteer should be chosen to perform local coordinating duties and liason duties."

a) Data from Interviews

The intent of this guideline was to provide some means of local coordination and liason with the computer centre. All teachers and administrators from both schools felt that the appointment of a local CAI coordinator was necessary and useful. The two coordinators, one at Handsworth and the other at Kelowna, indicated that the role they performed appeared to meet the expectations of their colleagues. Both agreed that their duties fell into three categories and, further, they agreed as to the proportion of their time spent on each duty. Beginning with the most demanding, they felt that organizational routines occupied approximately 75%

of their time. These routines included supervision of the student authors and monitors and registration of students. The second type of activity could be described as a catalytic role wherein the coordinator encouraged fellow teachers and student authors to develop CAI courses. They felt that about 15% of their time went into this role. The remaining time was devoted to the task of liason between the school, the computer centre, the investigator, and the visiting public. (See Appendix D for example of newspaper articles.)

In performing these duties, the coordinators indicated that the time allotted was inadequate. The Handsworth coordinator was given the equivalent of one day per week to perform his duties. The Kelowna coordinator received one extra "spare" period during the seven school day cycle. The Handsworth coordinator suggested a half-teaching appointment would probably suffice in view of the number of terminals, authors, and students. The Kelowna coodinator recommended that one day per week would be adequate at his school. Both coordinators expressed the desire for better training at the outset of the project. They felt that much time would have been saved if they had been more knowledgeable about the CAI system, the language, and the courses.

It would appear from the foregoing that this guideline was appropriate. However, the coordinators were quick to recommend adequate time in which to perform their various duties. Perhaps this time factor should be specified in this guideline.

Guideline 7. "Teachers should be involved in defining the objectives for CAI use at their school."

a) Data from Interviews

All interviewees agreed with this guideline but felt that it was not necessary to specify this guideline because it is generally assumed. Perhaps this guideline does not require specification.

B. Student Preparation

Guideline 8. "No necessary preparation is required except for instructions on how to use the CAI system. A CAI course on the use of the CAI system should suffice."

a) Data from Interviews

Teachers were evenly divided as to whether or not the students required preparation beyond the routine of actually using the CAI system. One half felt that students should be oriented to the concept of CAI so that they would use the CAI courses at approoriate times. Teachers felt that students would otherwise use CAI with no clearly defined purpose. These teachers suggested that it should be the responsibility of the subject teacher to be aware of the CAI courses so that he can direct students to specific CAI courses for help.

Ten of the fourteen student monitors indicated that the CAI introductory course, "INTRO," was adequate to provide instructions to student users. The other four felt that they had to provide additional help on many occasions. A short example of the "INTRO" program is available in Appendix P.

b) Data from Questionaire

Student questionaire responses indicated that 90% of students felt that "INTRO" was adequate in providing the necessary instructions to students wishing to use the CAI system.

It would appear that the guideline as specified may require modification to include an improved student orientation procedure.

(C) Initial CAI Programs

Guideline 9. "A search through indexes of CAI course materials should be made for possible sources of courses."

This guideline was considered by the teachers and administrators as an obvious and logical procedure. Logbook data indicated, however, that the search for suitable programs in both "Entelek" and the "Index for CAI" yielded nothing. Apparently Coursewriter III was a relatively new language and most of the courses listed pertained to university subjects developed by universities experimenting with the new language.

Guideline 10. "Initial programs should be relevant and "bug-free" and should minimize opportunities for student error."

a) Data from Interviews

Interview data received from teachers and administrators at both schools indicate unanimous support for this guideline. They felt that the courses chosen for this study were relevant and generally "bug-free". All teachers felt that a large majority of their students had taken at least one CAI course during the school year.

b) Data from Questionnaire

Over 80% of students responding to the questionnaire indicated that the initial Chemistry courses were relevant to their study, thus concurring with the data gathered from their teachers.

c) Data from Computer

As indicated previously, the computer maintained a "performance file" on each registered student. This data was analyzed to gain further insight into CAI course useage by students.

'Student status' data print-outs (Appendix K) indicated that a large majority of students who were registered for

CAI did not log any actual CAI utilization time. At Handsworth, particularly, 71% of the registered students for the CAI course, "BALEQN" (BALANCING EQUATIONS), showed no actual use of the course. Similarly, 84% of the registered students for "CODE" and 64% for "EXPO" did not show any terminal time. The only course which indicated a relatively good utilization rate was "SIGFIG" at 56%. This data would lead one to believe that students did not use CAI to the extent that was anticipated, as or indicated by student registration.

These data, moreover, contradicted the comments made by the teachers in their interviews. They reported that a large majority of their students had taken all or part of the above courses. This apparent contradiction may be explained by the fact that many of the students showing no CAI use have used the CAI courses under the "public" or "demonstration" codes rather than their own registration codes. The public codes were intended for course sampling by teachers, students, and visitors and were not intended for use by registered students. These codes were normally made up of alphabetic characters coded in such a way as to indicate the school. For example, Handsworth's public code was 'shands' ("student-Handsworth") and Kelowna, 'skelo'.

This explanation is supported to some extent by the evidence of a relatively large amount of CAI time logged under the public codes, an amount much greater than expected. The unfortunate aspect of public codes from this study's point of view is that the individual users cannot be identified in terms of how much time was spent, whether or not the course was completed, and when students last undertook the course.

Further evidence to this use of "public" numbers can be seen from the CAI monthly status reports. Appendix K lists all courses available on the CAI system. Looking at the "high school" courses, "CODE", "EXPO", and "SIGFIG", one can see a general increase in the use of the public numbers.

Corroborating evidence is also given by 'line status' data (Appendix K) whereby the command 'line status' results in a print-out of the codes and type of users at that very moment. On the basis of a number of samples using the "line status" command throughout the project, it was found that 53% of the CAI users in the combined samples were signed on under a "public" code. Thus it would appear that the 'student status' print-out failed to yield a true picture of individual student use. There were, however, sufficient numbers of students who took CAI courses under the

registration numbers to provide data as to the appropriateness of the initial programs guideline.

A further analysis of 'student status' data indicated that 60% of students who took two or more CAI courses took the CAI course, "SIGFIG", as their first course. Twenty-two percent of students who took two or more courses took "EXPO" as their first course. Twelve percent of students who took more than one course took either "CODE" or "BALEQN" as their initial course. Thus there appears to be some relationship between the nature of the initial CAI experience and subsequent CAI use.

Further analysis of 'student status' data revealed that the average time spent per CAI sitting was twenty-three minutes. This time appears to concur with the student questionaire data which indicated that 80% of the students chose 20 to 30 minutes as the average time spent on a CAI course per sitting. The average time for completion of each of the above mentioned courses varied. "SIGFIG" and "EXPO" had the shortest average completion times of 20 minutes and 29 minutes respectively. "CODE" had a relatively long average completion time of 55 minutes. "BALEQN" showed that no student ever completed the course while the average student use time was 87 minutes for this course.

In addition, it was noted that 90% of "SIGFIG" students who started the course completed the course. Of the students who used "EXPO", 75% completed the course. In contrast, 12% and 0% of "CODE" and "EXPO" students, respectively, completed those courses.

The foregoing data suggests that CAI courses that are capable of being completed within a half hour, on the average, stand a better chance of completion than courses longer than a half hour. Also, it would appear that the student whose initial course was completed within the half hour would tend to take a second CAI course more readily than a student whose initial course experience was in excess of a half hour. Thus a course length factor which was not considered in the preliminary guideline for initial CAI programs may be of some significance for future consideration.

(D) Program Development

Guideline 11. "Teachers should be involved in developing CAI programs for their curriculum needs."

Several CAI courses were developed at the schools. Only four of the ten completed programs were applicable to Chemistry. See Appendix O for list and description of courses. (An example of a student print-out is available in Appendix Q. Also an example of a course in its programmed language format (Coursewriter III) is available in Appendix R.)

a) Data from Interviews

Two of the three teachers at Handsworth and one of the three teachers at Kelowna supported this guideline. The non-supporters felt that this guideline was impractical in light of the available time that the average teacher has for such activities. One teacher felt that CAI course development should be left to specialists in the CAI curriculum development area. He compared the idea of each teacher developing their own CAI courses to that of each teacher having to write their own text book. Another teacher felt that most teachers lack the skills in curriculum and programmed teaching to develop effective CAI courses. From a cost-benefit point of view, she said that other forms of teaching resources could be better developed by teachers. She referred to such teacher-prepared resources as slide sets, overhead transparencies, film loops, and lab manuals.

The supporters of this guideline felt that teachers should be able to develop resource materials to suit their own needs. They were quick to point out the relevancy factor which is often omitted from non-locally prepared materials. Moreover, while they were very aware of the time problem, they felt that the local development of CAI courses is important and that time should be provided for developmental activities. Two suggested that the school district should recognize this need and provide the necessary time for CAI course development. In particular, one felt that the time for CAI course development should be recognized on the same basis as pupil "contact hours." Another teacher suggested that summer breaks be used for CAI course development and that teachers be paid for their work. He felt that this approach would solve three problems normally experienced by most teachers. One, the teachers would have uninterrupted time to pursue course development. Two, the teachers would be available for workshops on skills related to CAI course development. Three, the teachers would be under financial incentive to produce. This suggestion came from one of the two Handsworth teachers who, in fact, were contracted to prepare high school level Chemistry related programs over the two summer months preceding the school field trial. It was noted that three CAI programs, "CODE", "EXPO", and "SIGFIG", were produced

over this period. Whereas three Chemistry teachers (of which one was involved with the contract described above) produced three Chemistry related CAI programs over the entire school year with the assistance of student-authors. Thus it would appear that the productivity of the teachers was much greater when they were allowed large segments of uninterrupted time.

All administrators were in favour of the CAI development guideline in principle. However, all expressed some reservations as to the practicality of this guideline. The Administrative Assistant at Handsworth school felt that the teachers at Handsworth were already overworked with the existing school program and felt hesitant to suggest CAI program development as another task. The Principal supported the Administrative Assistant's feelings and added further that proper training in the area of course design would be a prerequisite and that, in itself, would add to the time problem.

The Principal at Kelowna school felt that CAI program development would not be essential during the first year or two of CAI use if there were a sufficient number of CAI courses made available. He stated that program development was a desireable and necessary professional endeavour,

however, it should be considered after the CAI system has been established. He felt that during the initial phase of CAI use, teachers should spend time gaining insights into effective CAI course design as well as effective CAI utilization which would help in CAI course development at the local level.

It would appear from the foregoing that the guideline specifying local CAI course development by teachers may not be appropriate in light of the time problem most teachers appear to be facing. The recommendations of teachers coupled with administrators' would suggest that recognized time, in the form of time off from teaching duties, or paid time other than regular school time should be considered as a means of providing time but only after at least one year of actual CAI use in the school.

Guideline 12. "Teachers and senior level students should join together as an authoring team whereby the teacher provides the curriculum material and teaching/learning strategy and the student assists by performing the actual CAI programming and debugging."

a) Data from Interviews

Five of the six teachers felt that the teacher-student authoring team was a viable procedure for program development. All six remarked how enthusiastic the students were about authoring. The one teacher who looked upon the authoring team unfavourably was adamant on this very point. He felt that some of the students got carried away with the technology and spent excessive time on the terminals to the detriment of their school work. On the other hand, another teacher felt that for one of his students the authoring experience was the most valuable aspect of the CAI system. Apparently this student was considering dropping out of school because he no longer felt motivated to stay. When given the opportunity to author, he apparently found this challenging and interesting. He has since decided on a career in the computer field.

The administrators were generally in favour of the teacher-author team. However, they supported the idea that some students got carried away with their programming duties and might neglect their regular school work. The administrators were both surprised and pleased at how quickly the students learned the CAI language, much of which was purely self motivated.

All six Kelowna student authors felt that the team approach to program development was not only a worth-while experience but was also enjoyable. One student confessed that he had spent too much time at authoring and not enough at his other studies. He was, in fact, barred from further authoring until he caught up in his studies. The students suggested that more terminals should be provided, that authors should have better assistance, and that student authors should be given course work credits for their endeavours.

The eight Handsworth student authors were selected from grades eleven and twelve by the coordinating teacher. All felt that Coursewriter III was easy to learn and that adequate instructions were provided. Most also felt that there was no difficulty in obtaining authoring assistance but admitted that they relied heavily on one another for assistance. They regarded the student-teacher authoring team as valuable but two authors confessed that they were more interested in the "art" of programming than in preparing instructional materials. Three authors felt that the sponsoring teachers lacked time to devote to the task of authoring and lacked knowledge of CAI capabilities. Consequently, these students admitted that they virtually developed some of the programs, both in content and format,

independently of their teachers. The common suggestions received were that the authoring teachers should be better informed in the aspects of CAI programming and that more terminals should be provided so that one may be devoted exclusively to authoring use.

It would seem that this guideline was generally favoured. However, the effective implementation of this guideline appears to depend on one main factor, namely, how much time teachers have for the preparation of course material and student author supervision.

(E) Administrative Concerns

Guideline 13. "The terminal(s) should be located in a room with the following features. First, the room should be easily accessible to student users throughout the school day. Second, the room should be located in an area where the noise from the terminal will not interfere with surrounding teaching areas. Third, the room should be sufficiently large to include not only the terminal and chair, but also worktables, resource materials, and a table and chair for the student monitor."

a) Data from Interviews

All teachers endorsed this guideline. In practice, however, they saw difficulties at their respective schools.

When questioned on the accessibility of the terminals, Handsworth teachers felt that the terminals were inaccessible during the first two months of the project. The reason being was that the student authors monopolized the terminal area during this period. The Handsworth coordinator spoke of an incident in which a student was involved in a fist fight with a student author when denied access to the terminals. This event led to a complaint to the principal by the student's parent. Consequently, the coordinator devised a users priority rating whereby high priority was given to students wishing to take CAI programs for course work during normal school hours. Students wishing the INTRO program and games were second on the priority list. Authors were given low priority during normal school hours but high priority between the hours of 3:30 and 5:30 in the afternoon. Upon the implementation of this priority system, Handsworth teachers felt that the terminals were accessible.

All Kelowna teachers felt that their terminal was not sufficiently accessible. Of the several reasons, the following were the main ones stated. First, they considered one terminal to be inadequate to serve the demand. Second, they felt that the security imposed on the terminal room, which was also the school's bookstore room, prevented students from using the terminal when they wished. This was considered a major factor in view of the shortage of monitors to keep the room open. Third, they felt that the space allotted for the terminal area was inadequate.

b) Data from Logbook

Logbook entries indicated that on the third week of September at Handsworth, the lab assistant working in the adjacent room complained about the terminal noise. In response to the complaint it was observed that the monitors and student authors sound-dampend the terminal room by gluing egg cartons to the walls.

Guideline 14. "The school should be on a program such as flexible modular scheduling which allows students access to the terminal throughout the day."

a) Data from Interviews

When asked whether or not their school schedule was conducive to CAI utilization, Handsworth teachers considered the flexible modular schedule in operation at their school was an ideal program because free study time was distributed throughout the school day and hence student use was similarly distributed. Kelowna teachers, in contrast, felt that their school's schedule was restrictive to CAI use. They stated that the block scheduling kept students in classes most of the day allowing only a few "spares" in the seven day cycle. Furthermore, one teacher felt that students tended to overload themselves with courses in a semester schedule in the anticipation of an early graduation. Consequently, few students had free periods for out of class learning. One teacher wished he could have had a terminal in his classroom. He felt that his students could have made effective use of the terminal during classes. He stated that he made a compromise and sent his students to the terminal during class time.

Administrators at Handsworth school felt that the flexible modular schedule in use at their school was one of the reasons for the apparently successful use of the CAI system. They stated that this type of scheduling allows a

large number of students free time for CAI use throughout the school day. Kelowna administrators felt that their block system may have limited student accessibility to the terminal, however, they stated that this type of scheduling is commonly used in B.C.

The foregoing results would appear to suggest that school scheduling may be one of the determining factors in CAI utilization. Flexible modular scheduling, as suggested by O'Neal (1970), appears to be conducive to CAI use. However, it was made apparent that "block scheduling" was commonly used in B.C. Thus the specification of this guideline appears to be correct but its application in the B.C. school system may be impractical.

Guideline 15. "Volunteer students should be recruited to perform monitor duties wherein they assist students with CAI routines, maintain the terminal room in good order, note any program difficulties, and "register" students for CAI courses."

a) Data from Interviews

The anticipated role of student monitors appeared to coincide with the activities actually reported by monitors.

Handsworth monitors felt that assisting students with the 'sign on' procedure for the "INTRO" course was the most frequent activity they performed. This was followed by policing and enforcing the priority system. They considered maintenance of the terminal room, restricting the number of students in the room, and discarding print-outs as the third most demanding activity. Kelowna monitors felt similarly except that they did not have a user priority system to enforce.

b) Data from Questionaire

Student questionaire results indicated that 95% of the students felt that monitors were necessary.

It would appear that Guideline 15 was appropriate.

III. SUMMARY

Without reviewing the findings in detail, it would appear that the preliminary guidelines related to technical specifications were appropriate. No apparent difficulties were encountered by using a general purpose computer on a time-shared basis, nor were any problems related to the typewriter terminal and telephone link evident. The

difficulties encountered with the CAI language supported the preliminary guideline specification that a reliable CAI language is an important factor in the successful use of CAI.

Administrative and personnel guidelines on the whole were appropriate. Data suggested that certain guidelines required modification and refinement. Data also suggested the need for additional guidelines. The inservice workshop for teachers was appropriate except that the one-day workshop was considered inadequate. The teacher-coordinator role was viewed by colleagues and by the coordinators themselves as necessary and useful but recommendations were made for more time to perform duties. Students felt that they received adequate instructions from the CAI INTRO course on how to use CAI. This finding was supported by monitors' interview data. Both students and teachers in the teacher-student programming teams felt that the concept had merit. They stated, however, that the time factor was the greatest stumbling block to the successful applicatior of this guideline. The monitor role was considered necessary and useful by teachers, students, and the monitors themselves. The perception of accessibility of the terminal(s) in the two schools differed markedly. Handsworth students and teachers felt that their terminals

were accessible while Kelowna teachers and students did not consider their terminal as accessible. Contributing factors to this difference of opinion may be the fact that Handsworth had two terminals whereas Kelowna had only one. Furthermore, the Handsworth terminal room was open at all times during school hours while the room in Kelowna, on the other hand, remained under lock and key. In addition, Handsworth students were on a flexible modular timetable schedule allowing a larger proportion of students free time to use the terminals as opposed to the block scheduling used at the Kelowna school.

Table 2 lists, in summary form, which guidelines appear to be appropriate, marginally appropriate, inappropriate and requiring more data. To minimize subjectivity of data interpretation that is often associated with studies of this nature, a definition of the categories was devised and is presented in Appendix S. These definitions may provide means for comparison and replication in similar future studies.

TABLE 2

SUMMARY TABLE OF APPROPRIATENESS

OF GUIDELINES IN LIGHT OF DATA

ANALYSIS

Guideline Number	Pertaining to	App.	Marg. App.	Inapp.	Insufficient Data
1	computer	X			
2	terminal	X			
3	commun. link	X		X	
4	CAI lang.	X			
5	workshop	X			
6	coordinator	X			
7	define obj.	X			
8	student prep.				X
9	avail. CAI.	X			
10	initial prog.	X			
11	CAI develop.			X	
12	author team		X		
13	access	X			
14	flex. modular				X
15	monitor	X			

CHAPTER V.

THE REVISED SET OF GUIDELINES

This chapter applies the results from Chapter 4 to the set of preliminary guidelines developed in Chapter 2. Each of the 18 guidelines is examined in the light of the results and is either supported, rejected or modified. This chapter concludes with a statement of the refined guidelines.

I. Technical Guidelines

A. The Computer

Guideline 1. "Rent computing service on a time-sharing basis from a general purpose computing facility."

This guideline was found to be appropriate as stated. No modification appeared to be necessary. It should be pointed out, however, that the computing centre used was that of an educational institution (SFU) which may be more sympathetic to the project than would that of a commercial computing facility. It may not be possible to apply, in general, the findings of this study to that of commercial computing facilities. Post (1970) may have had similar

thoughts when he suggested that the best source of shared computing service may be the universities and colleges.

B. The Terminal.

Guideline 2. "Rent teletype terminals that can be easily connected to the computer."

This guideline was found to be appropriate. The low rental cost and the need for "hard-copy" print-out were borne out by this study. The one objection raised, however, was in reference to the relatively slow typing speed of the terminal. In view of this objection and in view of the desire voiced by a Kelowna teacher, namely, to use a portable terminal right in the classroom, it may be appropriate to take advantage of advances in technology and recommend the use of the newer "non-impact" print terminals such as the Texas Instrument Silent 700 Series which uses an "electro-thermal" method of printing (Hillegass, 1974) or the Scope Series 200 KSR which uses an "electro-resistive" method of printing. (McLaughlin, 1973) These terminals, weighing approximately the same as an electric typewriter, print at twice the rate of a regular teletype terminal, yet only a slight murmur is heard. Perhaps this guideline should be modified to specify these newer terminals. Based

on their observations in the CAI classroom that the teletype terminal is noisy and distracting, Duncan and Slack (1970) would probably welcome these "non-impact" terminals.

Restated, Guideline 2 becomes: "Rent portable, high speed, silent, "hard-copy", terminals so that teachers may use the terminal directly in the classroom if so desired. The terminal should also be easily connected to the computer."

C. Terminal-computer communication

Guideline 3. "Rent telephone service from the existing public telephone network as a means of communication between terminal and computer."

In light of the results of this study, this guideline was found to be appropriate under one condition and inappropriate under another. The appropriate condition was one in which the distance between the terminal and the computer was a relatively few miles. Whereas, the inappropriate condition was one in which there were many miles between the terminal and the computer. Because the cost of communication service is based on a per mile per month charge, it was found that the cost for long distance terminal/computer 'hook-up' by telephone lines was

unreasonable in the view of school administrators. Thus it would appear that this guideline was appropriate only for short distance communication.

It would appear that this cost-distance factor should be included in the revised version of this guideline:

"Rent telephone service from the existing public telephone network as a means of communication between terminal and computer if the distance between terminal and computer is fairly small. Otherwise choose a computer that is within reasonable distance or reconsider the idea of implementing CAI."

It should be noted, however, that alternative means of data communications are available that have not been suggested for CAI use. These may or may not be less expensive and their possibility should be explored. Quinlam (1974) listed four current methods of communications which are used for business data transmission. First, there is the use of multiplexers by which several terminals are connected using only one telephone line. The multiplexer has the ability to transmit simultaneously a number of messages over the same line. Second, there are teleprinting service lines such as Telex or TWX. A third method is the

use of Wide Area Telephone Service (WATS). This service is provided on a bulk rate service and is considered economical if one uses the telephone for more than two hours per day. A fourth currently used method of data transmission is the use of multipoint networks. This enables several terminals to be "hooked-up", however, the system works on a "first come, first served," basis similar to a telephone party-line system.

It would appear that further study in the use of alternative, possibly less expensive, means of communications would be useful.

D) The CAI Language

Guideline 4. "Employ a well developed and reliable instructional authoring language."

This guideline appeared to be appropriate. The difficulty encountered in this study with Coursewriter III Version I underscored the importance of this guideline. One of the reasons that the use of the CAI system was poor during the initial period of this study was because of the unreliability of this language. However, when Coursewriter

III Version II was implemented and found to be reliable, the use of CAI increased markedly.

Perhaps this guideline should suggest that the CAI language should undergo preliminary testing well in advance of anticipated use in the school in order that any 'bugs' in the language may be worked out. This trial period should provide sufficient feedback as to whether or not the CAI system will be ready when needed. Teachers preparing to use CAI can plan their lessons accordingly.

Ottinger's (1969) warning concerning the unreliability of computer languages appears applicable to Coursewriter III Version 1. However, newer languages such as Coursewriter III Version 2, if indicative of the developing technology, may no longer come under suspicion of unreliability.

A re-stated Guideline Four would become: "Employ a well developed and reliable instructional authoring language. Provide adequate testing time to ensure that the language works reliably with the computer which is in use."

II. ORGANIZATIONAL GUIDELINES

A. Teaching Personnel

Guideline 5. "Teachers should be made fully aware of the concepts, capabilities, and limitations of CAI by means of introductory workshops."

The uanimous response of teachers and administrators surveyed indicated support for this guideline. There were, however, criticisms made of the application of this guideline in this study. The single most frequent criticism was that inadequate time was provided for the inservice workshop. The one-day workshop was not considered sufficient to allow teachers to grasp the various aspects of CAI and its uses. The suggestion that a program of inservice workshops on CAI should be organized over the initial year of CAI implementation appears to be a reasonable one. The workshop program could include such topics as, "the CAI system, what it can do for you as a teacher and for your students; learning the CAI language; designs for CAI authors; and the effective use of CAI in the classroom."

Another suggestion put forward by teachers was to provide an operating terminal during the workshops. They felt that the best way to understand the concepts of CAI was by actually trying it out. Perhaps this suggestion should be included in this guideline. Guideline 5, therefore, can be re-stated as:

"Teachers should be made fully aware of the concepts, capabilities, and limitations of CAI by means of a program of inservice workshops during the initial period (or year) of CAI use. An actual operating CAI terminal should be available during such workshops for the purpose of demonstration."

Guideline 6. "An enthusiastic teacher volunteer should be chosen to perform local coordinating and liason duties."

This guideline appears to be appropriate. The application of this guideline in this study, however, indicated that the time requirement for the role of the local CAI coordinator should be made explicit. In both schools, the teacher-coordinators found that the role demanded more time than was allotted by the school administrators. The time required appears to be related to

the number of students using the CAI facilities, the number of CAI courses available, and the number of authors. As no hard data was obtained as to time requirements for the coordinator role, no definite recommendations can be made. However, it may suffice to say that the time schedule of the teacher performing this role should be flexible enough to ensure that a problem does not arise from time limitations.

Re-statement of Guideline 6 would be:: "An enthusiastic teacher volunteer should be chosen to perform local coordinating and liason duties. During the initial phase of CAI utilization, the time allotted to this role should be flexible enough to allow designation of sufficient time for the task"

Guideline 7. "Teachers should be involved in defining the objectives for CAI use at their school."

It would appear that this guideline was appropriate. Data indicated that this guideline is often taken for granted. In light of this finding, it would appear that this guideline need not to be stated. Perhaps teachers at the time Trow (1963) made this recommendation were not as involved with the directions of educational practice in

their school as they apparently are today. However, it is the investigators opinion that, though this guideline may be implicit among the teaching staff, it should be made explicit. Watson (1967) perhaps would support this consideration in his recommendation for minimizing resistance to change.

B. Student Preparation

Guideline B. "No necessary preparation is required except for instructions on how to use the CAI system. A CAI course on the use of the CAI system should suffice."

There was no clear evidence obtained from this study as to whether or not this guideline was appropriate. Teachers were evenly divided on this question. Some felt that students did not require any preparation other than instructions on terminal use. Others felt that preparation in the effective use of the CAI system was necessary. Neither interviews with monitors nor student questionaires gave further insight into this expressed concern, although data received from these two groups suggested that students did not have any difficulty operating the terminals and that the CAI course, "INTRO" was adequate to instruct students on the use of the terminal.

It would appear that further study is required into the question of student preparation for CAI use. However, it can be stated that some form of preparation, whether in the operation of the terminal or in "signing on" for courses, appears to be necessary.

Guideline 8 can be re-stated as: "It would appear that students can learn to use the terminals by means of a CAI course. There may be a need to prepare students to make effective use of CAI.

(C) Initial CAI Courses

Guideline 9. "Indexes of CAI courses should be searched as possible sources of useable courses."

In actual fact, in this study search of two commonly used CAI course indexes, "Entelek" and the "Index for Computer-Assisted" revealed that very few programs were available in the Coursewriter III language. In view of the fact that few teachers felt that they had sufficient time to engage in CAI course development, it would seem important for a school to base its CAI language selection upon the languages in which the courses it wished to use from the

common indexes were written. Thus an additional constraint or criterion is placed upon the selection of a CAI language: it should not only be trouble free, but should be in common enough useage to be a language widely listed in CAI course indexes.

Thus a further revision of Guideline 4 would be: "Employ a well developed, reliable instructional authoring language which is frequently used in CAI course indexes. Provide adequate testing time to ensure that the language works reliably with the computer."

Attempts are currently being made to develop a standardized CAI language. (Lower, 1971) However, it appears that such attempts are very difficult in light of the differing hardware systems and the continuing improvements in languages.

Guideline 10. "Initial courses should be relevant and "bug-free" and should minimize opportunities for student error."

This guideline appears to be appropriate. The initial courses were considered "bug-free" and relevant by the teachers and administrators. They felt that these two

factors contributed to the initial and continuing interest students displayed. Questionnaire data indicated that 93% of students surveyed felt that the initial programs were relevant.

Analysis of computer record data indicated that courses which were completed within 30 minutes, on the average, stood a better chance of completion than courses which took longer. One possible reason is simply student fatigue. The mental involvement of the student with the program appears to be very intense. Perhaps students found that they became weary after about 20 to 30 minutes of CAI. Another possible reason is that their free time, particularly at Handsworth because of its modular scheduling, may have been scheduled on a thirty minute period basis. Perhaps students who did not finish within the 30 minute module did not bother to return later to complete the course. The analysis of the student questionnaire, which reports that average time spent was 20 to 30 minutes per CAI session corroborates the above findings.

Furthermore, it was noted that 23% of students who, for their initial CAI experience, had used courses that took them longer than 30 minutes to complete, did not take subsequent CAI courses. Whereas 77% of students who took

courses shorter than 30 minutes as their initial CAI experience undertook further CAI.

As noted earlier, Mathis, Smith, and Hansen, (1969) determined three factors which appear to affect student attitudes toward CAI. These were relevancy, reliability, and programming strategy (students should not be allowed to make too many errors). From the results of this study, a fourth factor is suggested, namely, initial course completion time. Further study is required, however, to confirm this suggestion.

Guideline 10 may be re-stated as follows:

"Initial programs should be relevant and 'bug-free' and should minimize opportunities for student error. Also such programs should be of reasonable length in terms of time required for completion."

An interesting observation was made during the analysis of computer data which may warrant an additional guideline recommendation. It was noted that many students did not use the registration number assigned to them. Instead they chose to use the "public" code which was intended for demonstration and course sampling only. Several reasons can

be suggested for this unexpected occurence. Students may simply have forgotten their four digit code. Perhaps students became interested in a course while sampling using a "public" code and decided instead to complete the course. Possibly students wished to remain annonymous and chose to use the "public" codes because student records stored by the computer under this code were not traceable to specific students. It would appear that further study should be conducted on this aspect alone. The results of the study may have implications as to whether or not student registration is necessary or even desireable particularly in view of the fact that the CAI system was to be used as a remedial/enrichment learning device. Record keeping of student's performance may in fact, deter student use. This conjecture is based on the "anti-big brother" surveillance attitude that seems prevalent among some students, particularly aimed at computers. Perhaps student registration could be voluntary, allowing for those who wish to have their interactions recorded for the purpose of problem diagnosis.

In light of this discussion, the following guideline may be applicable: "Students should be encouraged to register for CAI courses in order to take advantage of the automatic student interaction recording mechanism inherent

in the CAI language. These records may be useful for problem diagnosis. However, students should also be allowed to use the "public" or "annonymous" code should they desire to."

(D) CAI Course Development

Guideline 11. "Teachers should be involved in developing CAI courses for their curriculum needs."

In view of the data analysis, this guideline appeared to be inappropriate as stated. Teachers reported that time constraints imposed upon them prevented their involvement in CAI curriculum development activities. The suggestion of using the summer holiday months for CAI course development appears to be aopropriate. The productivity of teachers when given uninterrupted time to develop CAI courses appears to be greater than during regular school times. It would appear that further study may be necessary on ways and means to provide time and incentive for teachers to undertake CAI curriculum development. Perhaps Guideline 11 should be re-stated as: "Teachers should be encouraged possibly by extra renumeration during vacations or by release time, to develop CAI courses for their curriculum needs. Large segments of uninterrupted time, such as the summer months,

with a stipend, appears to be the kind of encouragement that is required."

Guideline 12. "Teachers and senior level students should join together as an authoring team whereby the teacher provides the curriculum material and teaching/learning strategy and the student assists by performing the actual CAI programming and debugging."

In light of the inappropriateness of Guideline 11, the appropriateness of this guideline may be a foregone conclusion. According to data analyzed, however, this guideline could conceivably be considered as at least moderately appropriate. Teachers and administrators felt that the value of this guideline was not in the development of CAI courses, but lay in the student-authors themselves. The motivation displayed by virtually every student-author performing his authoring duties was considered more valuable than the actual course produced. Not only did these student-authors learn about the subject matter, but they also learned about teaching strategies, CAI strategies, and computers in general. However, it was evident that some of these students became so highly motivated and spent so much time authoring programmes that their regular school work suffered.

In view of the benefits to the student-author himself and in view of the time problem faced by teachers, perhaps this guideline should allow for student-authoring on an extra-curricular basis. Interested students could form a 'computer club' headed by an interested teacher through which special student projects could be sponsored.

Guideline 12 may therefore be re-stated as: "Provision should be madefor interested students to author in the CAI "first-come/first served basis" schedule. More often than not, students wanting to use CAI became frustrated with waiting and would leave. As a result, a "users priority" system was developed to ensure that students wanting CAI courses related to their studies would have priority over all other users. Upon implementation of this priority system, teachers and monitors felt that the terminal was accessible. It would appear to be sensible to recommend an additional guideline which specifies the need for a reservation and/or priority system.

Guideline 14. "The school should be on a program such as flexible modular scheduling which allows students access to the terminal throughout the day."

This guideline was found to be, in principle, an appropriate means of ensuring that students have time for the use of the CAI system. At Handsworth where the flexible modular schedule was in use, this guideline was considered appropriate. Kelowna, on the other hand, was on the conventional "block" system which appeared to have hindered students from using the CAI system. In view of the fact that the block system is the more prevalent schedule in B.C. schools, it would appear that this guideline, although found to be appropriate, may be difficult to implement. Perhaps the implementation of Guideline 2 may be the answer for those schools on the block system. The terminal could then be used in the classroom under the auspices of the subject teacher. This procedure would ensure student access to the terminal regardless of their timetables.

In light of the foregoing, it appears that the guideline requires no modification. However, this guideline may not be necessary if Guideline 2 is implemented and advantage is taken of in-class use of the terminal.

Guideline 15. "Volunteer students should be recruited to perform monitor duties wherein they assist students with CAI routines, maintain the terminal room in good order, note any course difficulties, and "register" students for CAI courses."

This guideline appears to be appropriate and requires no modification. Data analyzed indicate that the student monitors performed a necessary and important function in the organizational aspect of CAI use as similarly noted by O'Neal (1970).

In summary, varying degrees of modification were necessary to the original set of guidelines. Guidelines pertaining to technical recommendations, on the whole, were appropriate as stated. One of the most significant modifications was in the terminal specification. The recommendation to use silent, high-speed, portable, "hard-copy" terminals has implications for guidelines pertaining to organization. The other modification suggested that careful consideration be given to the distance between the computer and the school. The cost of communication was found to be prohibitive over long distances.

The set of organizational guidelines underwent major revision. Revisions here included changes pertaining to inservice CAI workshops for teachers, the role of local teacher coordinator, and student-authoring of CAI programmes.

The guideline recommending that one should make a thorough search for available CAI courses was amalgamated with Guideline 4, the recommendation for CAI language.

Additional guidelines to existing guidelines included the recommendation for voluntary student registration and

establishment of a reservation and/or priority system for CAI users.

Insufficient data resulted in inconclusive support for the guideline pertaining to student preparation.

III. The Revised Set of Guidelines

I. Technical Guidelines

A. The Computer

Guideline 1: "Rent computing service on a time-sharing basis from a general purpose computing facility."

B. The Terminal.

Guideline 2: "Rent portable, high speed, silent, "hard-copy", terminals so that they may be used in the classroom or in other areas of the school as needed."

C. Terminal-computer communication

Guideline 3: "Rent telephone service from the existing public telephone network as a means of communication between

terminal and computer if the cost-distance factor is considered reasonable. Otherwise choose a computer that is within reasonable distance or reconsider the idea of implementing CAI."

D. The CAI Language

Guideline 4: "Employ a well developed reliable instructional authoring language which is frequently useed in CAI course indexes. Provide adequate testing time to ensure that the language works reliably in the computer."

II. Organizational Guidelines

A. Teaching Personnel

Guideline 5: "Teachers should be made fully aware of the concepts, capabilities, and limitations of CAI by means of a program of inservice workshops during the initial period (or year) of CAI use. An operating CAI terminal should be available for the purpose of demonstration during workshops."

Guideline 6: "An enthusiastic teacher volunteer should be chosen to perform local coordinating and liason duties.

During the initial phase of CAI utilization, the time allotted to this role should be flexible until the time demands of the role are known."

Guideline 7. "Teachers should be involved in defining the objectives for CAI use at their school."

B. Student Preparation

Guideline 8: "Students can learn to use the terminals by means of a CAI course. There may be a need to prepare students to make effective use of CAI per se.

C. Initial CAI Courses

Guideline 9: "Initial courses should be relevant, "bug-free", and should minimize opportunities for student error. Programs should generally be of reasonable length (requiring approximately thirty minutes for completion."

Guideline 10: "Students should be encouraged to register for CAI courses in order to take advantage of the automatic student record-keeping mechanism inherent in the CAI language. This recording may be useful for problem diagnosis. However, students should also be allowed to use the "public" or "annonymous" code should they desire to."

Guideline 11: "Provision should be made so that interested students can author with the CAI system for the purposes of learning author programming techniques and for development of CAI courses such as games and other extra-curricular courses."

(D) CAI Course Development

Guideline 12: "Teachers should be encouraged to be involved in developing CAI courses for their curriculum needs. Large segments of uninterruoted time, such as during summer months with a stipend, appears to be the kind of encouragement that is required."

(E) Administrative Concerns

Guideline 13: "The terminal(s) should be located in a room with the following features. First, the room should be easily accessible to student users throughout the school day. Second, the room should be located in an area where the noise from the terminal will not irterfere with surrounding teaching areas. Third, the room should be sufficiently large to include not only the terminal and chair, but also worktables, resource materials, and a table and chair for the student monitor."

Guideline 14: "The school should be on a program such as flexible modular scheduling which allows students access to the terminal throughout the day during free-study time."

Guideline 15: "Volunteer students should be recruited to perform monitor duties wherein they assist students with CAI routines, maintain the terminal room in good order, note any course difficulties, and "register" students for CAI courses."

Guideline 16: "The school should consider the implementation of a reservation and/or priority system for CAI users."

As noted earlier, Guidelines 13 and 14 may not be necessary if the "in-classroom terminal" concept is employed as suggested in Guideline 2. However, further study in the aspects of "in-classroom terminal" use would be necessary before a recommendation can be made to delete Guidelines 11 and 13.

CHAPTER 6

DISCUSSION AND RECOMMENDATIONS FOR FURTHER STUDY

As stated at the outset, the purpose of this study was to develop and refine guidelines related to the use of CAI in Secondary schools. The procedure included a review of the literature from which an initial set of guidelines were derived. Upon field testing in two B.C. Secondary schools, the initial set of guidelines was refined in light of the data analyzed. A refined set of guidelines has been stated.

It appears that the purposes were accomplished. The refined set of guidelines, though not definitive, appears to have made a useful step toward a comprehensive set of guidelines which would enable a Secondary school to utilize the full potential of CAI with a minimum of difficulty and with maximum effectiveness.

1. Recent Developments

Recent technological advancements in the area of computer technology may be applicable to assist in the approach to this ideal. The use of communication networks such as satellites, microwave, cable television, and laser systems (Martin, 1969) may provide answers to the problem of terminal-computer communications costs.

Martin and Norman (1970) predicted that computer terminals will be a common place item in the home of the future. They liken the purchase of colour television sets during the mid sixties through mid seventies to the purchase of computer terminals in the mid severties through mid eighties. They foresee the household use of computers not only for CAI needs, but also for shopping, scheduling for appointments, medical diagnosis and prognosis, and information retrieval.

Buckelew and Pennimen (1974) wrote about the system currently undergoing market evaluation. The system is based on the use of two-way cable television networks. The user has a small hand-held keyboard terminal which is plugged into the television set. The data transmitted and received is displayed on the screen. The data transmission to and from the computer is via the cable television network.

Alpert and Bitzer (1969) of Project PLATO, have developed a new terminal for CAI. Using a "plasma" screen, the terminal provides for character generation on the screen and, simultaneously, computer controlled colour visuals in the form of slides projected onto the back of the screen.

Similarly, computers themselves are becoming smaller. Advancements in integrated circuitry have shown that complete computing systems can be built in an area no larger than a postage stamp.(Hafford and McWhorter, 1972) Perhaps, it may be fully possible for each school to have its own computer in the not too distant future.

Currently, new developments are taking place in the use of the computer in education. With the advent of the time-sharing system and the development of "on-line" interactive computer programs, the uses of the computer in

education appears to go beyond the scope of traditional educational use. For example, the development of APL (A Programming Language) has now minimized the need for learning special computer languages which are often perplexing. APL, instead, comes very close to normal English useage. Thus, the barrier between the user and the computer is lowered. As a result, there appears to be a tremendous amount of interest shown by schools in using this language for the various computational needs of their students. Handsworth school, as an example, continued with the rental of the terminal after this study was completed. The Handsworth teacher/coordinator has since reported that students are increasingly requesting APL over CAI. This may be indicative of the ease of use and new direction of use of computers in schools.

Another new interactive language which is experiencing tremendous demand is WYLBUR. WYLBUR is designed for text editing, that is, one can manipulate data, whether numerical

or textual, by very simple commands to the computer. A very good example is this thesis, which was written utilizing the WYLBUR facilities. The writer was able to make corrections and revisions to the draft thesis, which was "stored" in the computer. Upon command from the writer, the computer would print the revised material.

In light of the foregoing discussion, it would appear that major changes in computer systems and computer use will occur in the near future. Some of the difficulties associated with the use of CAI in schools disclosed by this study, may be easily overcome by these changes.

It is the opinion of the author, however, that there may not be a correspondingly bright future for CAI course development. The availability of CAI courses, like the availability of any learning resource, will have an impact on whether CAI will become an integral part of the school system. The time, expertise, and costs required to produce CAI programs appear to be prohibitive at the present time. Coupled with the lack of standardization of CAI languages, CAI appears to be reserved for schools wishing to

experiment. In light of some of the new uses of computers in education mentioned above, perhaps CAI, per se, should be considered as only one aspect of a computer based system in the school. Emphasis on the other uses of computers should be made. Perhaps, then, the cost-effectiveness in a total school computing system of CAI would support the use of CAI in typical public schools.

2. Suggestions for Further Study.

Retrospectively speaking, the investigator would make one major change in the design of this study. Instead of conducting the study only over one year, the study would be conducted over a period of at least three years. By doing so the "Hawthorne" effect (Roethlisberger and Dickinson, 1939) could possibly be minimized. Moreover, students and teachers would be more familiar with the CAI system by the second year of operation and subsequent years of use would provide more substantive data.

Because the scope of this study was broad, there are many aspects of the use of CAI in schools suggested by the study which may warrant further study. For example, further study of the question of terminal use, particularly in the classroom, should be carried out. Further study in all

aspects of CAI course development appears to be necessary. Further study of the value of student-authoring could yield interesting results on the motivational aspects of computer use. An in depth study of factors which affect CAI course utilization appears also to be a fundamental need. Furthermore, the guidelines derived in this study could now also be submitted to a panel of experts in CAI and computing for further refinement, ranking, and so on, by using a questionnaire-type device.

It is hoped that the guidelines developed by this study have contributed to the goal of more effective and widespread use of Computer-Assisted Instructions at the Secondary school level. In particular, the employment of these technical and organizational guidelines may assist secondary schools to minimize the need to spend financial resources, time, and energy on the "re-irvention of the wheel" and instead, channel these resources to the teaching/learning objectives of the schools.

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Appendix A

Excerpt of letter from B.C. TELEPHONE CO. to Dr. Ellis.
RE: communications cost for project

BRITISH COLUMBIA TELEPHONE COMPANY

700 SEYMOUR STREET, VANCOUVER 1, CANADA TELEPHONE 688-8181 AREA CODE 604

D. C. WATT
VICE-PRESIDENT—MARKETING

RECEIVED
APR 17 1970

April 16, 1970

Professor J. F. Ellis,
Professional Development Centre,
Simon Fraser University,
Burnaby 2, B.C.

Dear Professor Ellis:

This will acknowledge and thank you for your letter of April 10, 1970, concerning the computer instruction project at Handsworth School in North Vancouver and Kelowna Senior Secondary School.

The following sets forth the monthly rentals and non-recurring installation charges which will apply:

a) S. F. U. to Handsworth Secondary School, North Vancouver

16 miles @ $2.50	$ 40.00 per month
2 - 103A2 data sets @ $35.00	70.00 per month
Total	$110.00
Service Charge	$ 60.00

b) S. F. U. to Kelowna Senior Secondary, Kelowna

170 miles @ $2.50 per mi.	$425.00 per month
2 drop charges @ $10.00	20.00 per month
2 - 103A2 data sets @ $35.00	70.00 per month
Total	$515.00
Service Charge	$ 60.00

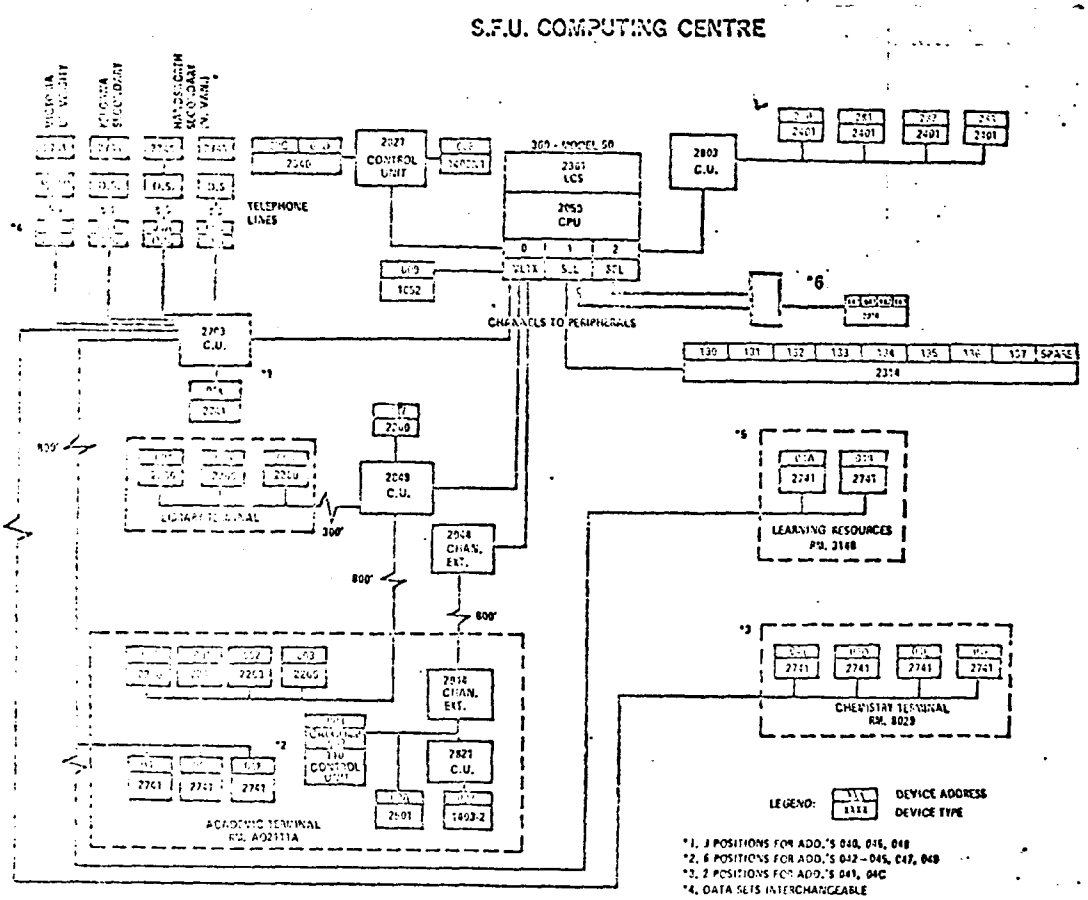
Combined Charges (a and b)

Recurring	$625.00 monthly
Non-recurring	$120.00

As mentioned in our telephone conversation, we are prepared to assist you in this project for a period of twelve months and, over that period, you may expect to be billed initially for the $120.00 installation charge, and $625.00 monthly for the rental of the facilities involved.

Appendix B

TECHNICAL DESCRIPTION OF COMPUTER, TERMINAL, COMMUNICATION DEVICE, AND CAI LANGUAGE



SYSTEM/360 MODEL 50

FEATURES
2050 CPU Main Storage (512K)
2361 LCS Core Storage (1024K)

Input/Output Devices**

DEVICE TYPE		CONTROL UNITS** DEVICE ADDRESS	UNIT TYPE	
IBM 2314	Direct Access Storage Facility	120-137 140-143	IBM 2848	Display Control for 2260's
IBM 2260	Display Station	003-007	IBM 2703	Tape Control for 2401's
IBM 2401	Magnetic Tape Unit	280-283	IBM 2821	Control Unit for 1403-2
IBM 1052	Printer – Keyboard	009	IBM 2821	Control Unit for 1403N1 and 2540
IBM 1403-2	Printer (600 lines/min.)	008	IBM 2703	Transmission Control for 2741's
IBM 1403-N1	Printer (1100 lines/min.)	00E		
IBM 2501	Card Reader (600c/min.)	00A	Calcomp 110	Control Unit for 563
IBM 2540	Card Reader (1000c/min.) Punch (300c/min.)	00C/000		
IBM 2741	Keyboard Terminal	040		

Appendix C

SFU CHEMISTRY CAI PROGRAMS AVAILABLE TO SECONDARY SCHOOLS

Course Name	Course Description
baleqn	Practice in balancing oxidation reduction equations
eranl	Principles of error analysis
gaslaw	Basic laws of gas behaviour
intro	Introduction to the CAI terminals and course facilities
irlang	Basic concepts of Coursewriter III (CAI author language)
code	Writing and naming chemical formulas
expo	A study of exponential numbers
sig fig	Study of significant figures for Chemistry 11

Appendix D

COURSES PROGRAMMED BY TEACHER-STUDENT AUTHOR TEAMS

1. Handsworth teams

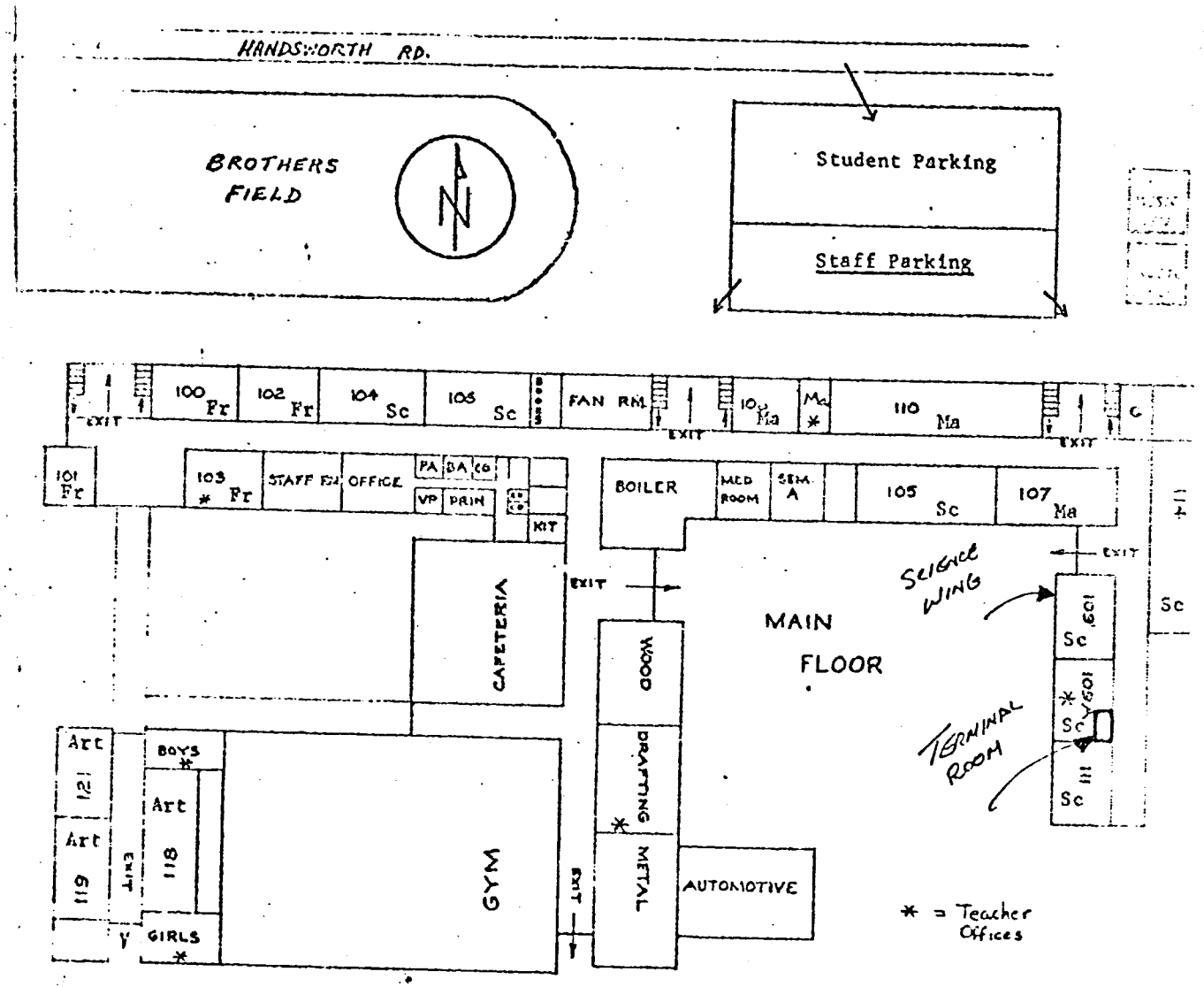
Course Name	Description
bioll	Biology 11, Meois, Metosis
cangov	Canadian Government; study of the Parliamentary system
elecl0	Basic electricity grade 10
geog	Geography grade 11
linequ	Linear equations
molell	Mole concept for Chem. 11
shorst	Short stories; analysis
urban	Urbanization concepts

2. Kelowna teams

Course name	Description
cellif	Study of cellular structure
factor	Factor analysis
naplo	Napoleon; a simulation game
shakes	Study of Shakespeare

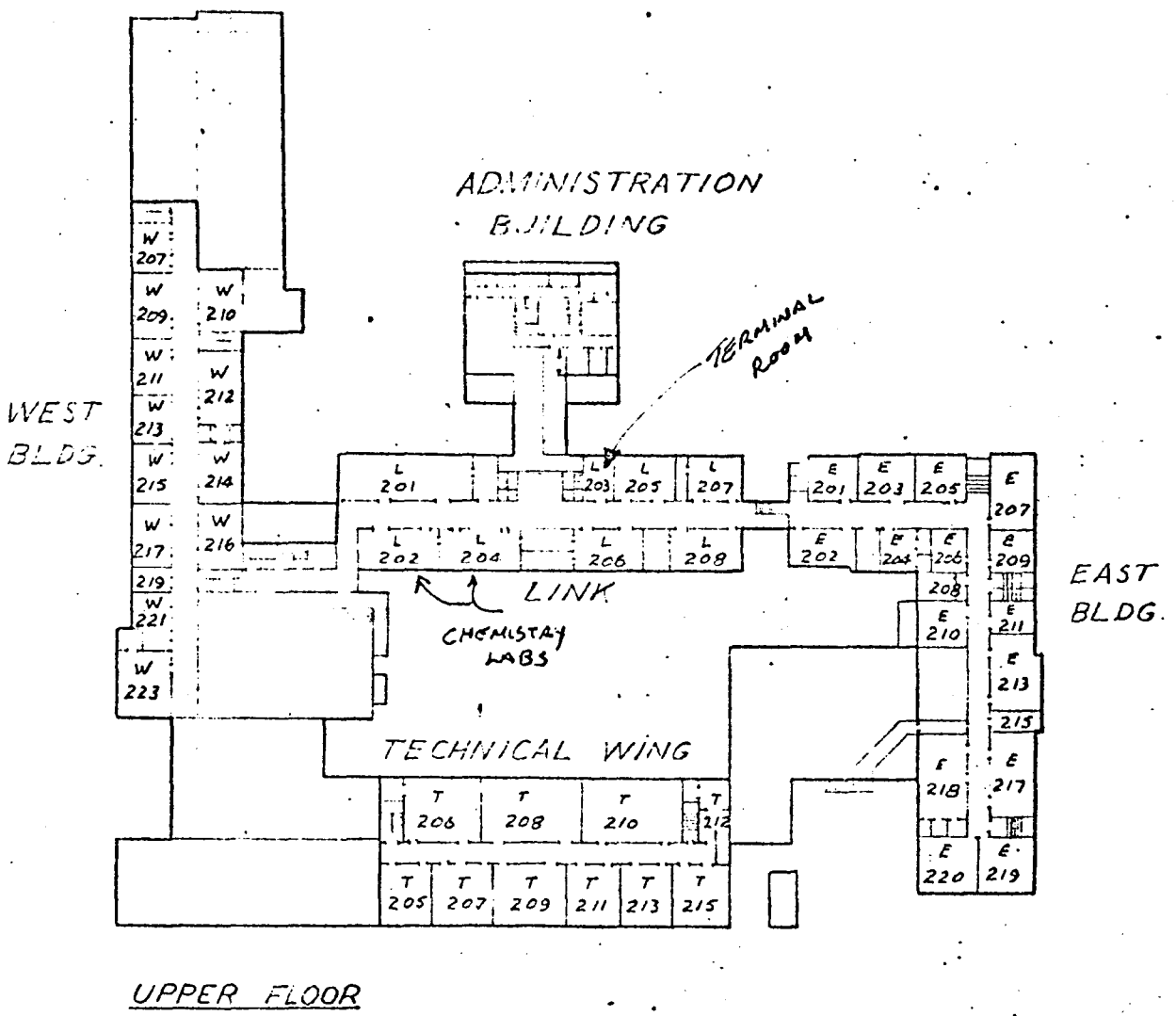
Appendix E

SCHEMATIC DIAGRAM OF LOCATION OF TERMINALS
HANDSWORTH



Appendix F

SCHEMATIC DIAGRAM OF LOCATION OF TERMINAL
KELOWNA



UPPER FLOOR

Appendix G

EXAMPLES OF "LINE STATUS" AND "STUDENT STATUS" PRINT-OUTS

```
01/25/71        12:19              LINE 9
TYPE COMMAND

line status all

LINE        COURSE      GROUP       USER NO    DATE 1/25/71 Time 12:20

1           mpl         vis         start
2           elec10      sam         sample
3           beleqn      h20         sh745
4           cellif                  author
6           cai         vis         sample
7                                   SUPERVISOR
8           cai         vis         start
9                                   MONITOR
```

```
  THIS IS THE LISTING FOR SIGFIG DATE 03/30/71 TIME 14:24 ALL ::::::::::::::::
STUDENT STATUS SIGFIG DATE 03/30/71 TIME 14:24 SELECTION=ALL
SEG LABEL PASS-SEQ START DATE LAST DATE TIME TYREC STUDENT NO. GROUP AREA STUDENT

00 SIGFIG-  0-  0  12/30/69              00:00  0      TEVE   PRO  1  S→ K→ LI
00 SIGGIG-  1-  4   3/04/70  2/11/71     2:58   8      AMPLE  VIS  1  INSIGNII
00 SYS1  -  2-  1  10/16/70  3/26/71     0:04  15      TART   VIS  1  SIGNIFIC
00 SIG7  -  1- 34  10/30/70  11/09/70    00:11  15      7847   H04  1  VICIE CI
00 SIGFIG-  2-  4  12/04/70  12/04/70    00:01  15      7927   H04  1  CAROL ME
00 END   -  0-  0  11/18/70  11/18/70    00:24  15      7940   H04  1  BOB GALL
00 SIGFIG-  2-  4  11/24/70   1/04/71     00:28  15      4444   H02  1  DON FAIF
00 END   -  0-  0  12/10/70  12/10/70    00:25  15      7984   H04  1  GEOFF DA
00 END   -  0-  0   3/10/71   3/10/71    00:10  15      8010   H04  1  PAM BROA
00 END   -  0-  0   1/12/71   1/12/71    00:18  15      8012   H04  1  NANCY BF
00 SYS5  -  1-  4  11/04/70  11/04/70    00:21  15      8059   H04  1  KATHY BR
00 SYS5  -  1-  5  11/10/70  11/23/70    00:42  15      8060   H04  1  LAURA CC
00 SIGFIG-  0-  0  10/30/70              00:00  15      8077   H04  1  DEBBIE J
00 ANTHER-  2- 13  12/10/70   2/16/71     00:18  15      8092   H04  1  BLAIR PR
00 END   -  0-  0   3/12/71   3/12/71    00:23  15      8095   H04  1  LESLIE h
00 SYS5  -  1-  5  11/18/70  11/18/70    00:20  15      9699   H04  1  ERIC PED
00 SYS1  -  1-  2  11/26/70  11/26/70    00:13  15      9765   H04  1  BRETT MA
00 END   -  0-  0   1/27/71   1/29/71    00:10  15      0565   H04  1  ROBYN CR
00 SIGFIG-  0-  0  10/30/70              00:00  15      0706   H04  1  SUE WALD
00 SIGFIG-  0-  0  10/30/70              00:00  15      7555   H01  1  MARGARET
```

Appendix H

EXAMPLE OF INTERVIEW SCHEDULE: TEACHER, ADMINISTRATOR, STUDENT-AUTHORS, MONITORS, COMPUTING CENTRE PERSONNEL

TEACHER INTERVIEW SCHEDULE	Positive	Neutral	Negative
1. We have specified the use of a general purpose computer which is located several (hundred for Kel.) miles from your school. What are your feelings on this remote use of the computer?	3(H) 3(K)		
2. Teletype terminals were chosen for this study over the faster information displaying television like terminals because it was thought that the typed print-out would be useful. Do you think the choice of teletype terminals over television like terminals was a good decision.	2(H) 3(K)		1(H)
3. The guideline for CAI language recommends the use of a reliable language. Would you comment on this guideline?	3(H) 3(K)		
4. The guideline pertaining to teacher preparation specified that inservice workshops be given to introduce the concepts, capabilities, and limitations of the CAI system. What are your comments on this guideline?	3(H) 3(K)		
5. Local CAI coordinators were appointed at the beginning of this project. What is your opinion of the role of the coordinator?	3(H) 3(K)		
6. Would you please comment on the initial Chemistry programs that were made available to			

your students in light of the guideline recommendation for initial programs: initial programs should be relevant and "bug-free" and allows students to make few errors.	3(H) 2(K)	1(K)		
7. One guideline recommendation stated that teachers should be involved in developing CAI courses. Please comment on this guideline.	1(H) 1(K)	1(K)	2(H) 1(K)	
8. This study recommmended the use of senior students to perform the actual mechanics of CAI programming allowing teachers to spend their time on course content and design. What are your opinions of this student-teacher authoring team approach to course development?	2(H) 2(K)	1(H) 1(K)		
9. One guideline specified that the school schedule should allow student access to the terminal throughout the day on non-schedule basis. It was suggested that flexible modular scheduling may be one of the most effective. Please comment on this guideline.	3(H) 3(K)			
10. The administrative orgainization of the terminal location was specified for maximum accessibility and minimal disturbance caused by the typing of the terminal ball. Please comment on this recommendation.	3(H) 3(K)			

Administrator Interview Schedule				
1. The computer guideline specifies that a school wishing to use CAI should rent computing service from a general purpose computer on a time-shared basis. The rationale for this is that no capital funds are required and that no major long term financial and personnel commitments are made. Please comment on this guideline.	2(H) 2(K)			
2. As you know, the computer is located several (hundred for Kelowna) miles from the school. What are your feelings on the remote use of the computer? to your staff or students?	2(H) 2(K)			
3. The best estimate of actual computing time cost has been calculated to be approximately $15.00 to $20.00 per school day on 90% utilization. Please comment on this cost as to whether or not you consider it reasonable.	2(H) 2(K)			
4. The rental charge for the terminal is approximately $100.00 per month. Do you find this cost a reasonable or unreasonable amount in terms on school financing?	2(H) 2(K)			
5. The telephone charges for rental of service and data connecting device (data set) is approximately (Handsworth) $100.00 per month per terminal. (Kelowna) $700 per month per terminal. Do you	2(H)		2(K)	

find this cost a reasonable or unreasonable amount in terms of school financing?				
6. One of the guidelines state that inservice workshops should be given to teachers on the concepts, capabilities, and limitations of CAI. Please comment on this guideline.	2(H) 2(K)			
7. Local CAI coordinators were appointed at the beginning of this project. What is your opinion of the role of the coordinator?	2(H) 2(K)			
8. Would you please comment on the initial Chemistry programs that were made available to your students in light of the guideline recommendation for initial programs: initial programs should be relevant and "bug-free" and allows students to make few errors.	2(H) 2(K)			
9. One guideline recommendation stated that teachers should be involved in developing CAI courses. Please comment on this guideline.	1(K)		2(H) 1(K)	
10. This study recommended the use of senior students to perform the actual mechanics of programming allowing teachers to spend their time on course content and design. What are your opinions of this student-teacher authoring team approach to course development.	2(H) 2(K)			
11. One guideline specified that the school schedule should allow student access to				

the terminal throughout the day on non-schedule basis. It was suggested that flexible modular scheduling may be one of the most effective. Please comment on this guideline.	2(H) 2(K)			
12. The administrative orgainization of the terminal location was specified for maximum accessibility and minimal disturbance caused by the typing of the terminal ball. Please comment on these recommendations.	2(H) 2(K)			
Rating	Positive	Neutral	Negative	
Interview Schedules				
Student-Authors				
1. Was the CAI language easy to learn and use?	7(H) 4(K)	1(H) 1(K)	1(K)	
2. What are your feelings about the teacher-student team approach to authoring?	6(H) 4(K)	1(H) 1(K)	1(H) 1(K)	
3. Would you like to continue with authoring?	8(H) 6(K)			
4. What recommendations would you make to improve the student authoring process?				
Monitor Interview				
1. Do you think monitors are necessary?	12(H) 10(K)			
2. What are your feelings about "INTRO" as a course to instruct students on how to use the CAI system?	7(H) 7(K)	3(H) 2(K)	2(H) 1(K)	

3. What do think about the accessibility of your terminal?	8(H) 2(K)	1(K)	4(H) 7(K)	
4. What kinds of activities did you do as a monitor?				

Appendix I

EXAMPLE OF QUESTIONNAIRE ADMINISTERED TO STUDENTS

QUESTIONNAIRE: HANDSWORTH/KELOWNA CAI PROJECT 1971

This questionnaire is directed at Chemistry students who have taken at least one Chemistry CAI course during this school year.

Please fill in your response on the "Mark Sense" forms in pencil. Enter only ONE response per question. Please NOTE that you enter your responses ACROSS the page.

1. My grade is: A) 12 B) 11 C) 10 D) Lower

2. Each time I used CAI, the number of minutes I spent at the terminal was approximately:

A) less than 5 minutes
B) 5 to 10 minutes
C) 10 to 20 minutes
D) 20 to 30 minutes
E) 30 to 60 minutes

Rate the following statements as to whether you
A) agree B) partially agree C) undecided D) partially disagree
E) disagree

3. I found "INTRO" adequate for giving me instructions on how to use CAI.

4. I found the Chemistry courses relevant to my studies.

5. I could use the terminal(s) whenever I wished.

6. I found that my timetable schedule allowed me to use the CAI system often.

7. The student monitors were useful.

8. I enjoyed using CAI.

Apoendix J

SAMPLE OF INTERVIEW SCORING: POSITIVE, NEGATIVE, NEUTRAL RESPONSES

Examples of Positive, Neutral, and Negative Resporses.

Interview question No. 7 directed at teachers:

"One guideline recommendation stated that teachers should be involved in developing CAI courses. Please comment on this guideline."

Response rated Positive:

"Oh yes. I think teachers should be involved. That's part of the professionalism thats expected from them. The only problem I see at the moment is time. They're already involved in their own special projects. It be asking a bit much to lay CAI programming on them too. Maybe later, especially after we see what happens with the project. I mean, if the Board supports the expenses (CAI costs) I like to see some of us get together on a group basis. After all, what's good of CAI if we don't have courses. But I like to be sure that the Board will support the system first. I don't want to spend too much time on programming if its not guaranteed that we can use them. This is why I felt a little reluctant to spend too much time on this CAI project this year."

Response rated Neutral.

"Well, I'm not so sure. You know, one of the problem is time. But I think there's even a greater problem. From what I saw pf some of the programming that's going on, I think we need some guidance on program design. But that even takes time. Perhaps programming should be left to the experts...whoever they are. I don't know. I'd like to see what teachers can do if they're given workshops on program design."

Response rated Negative.

"No way. It takes too damn much time. I could give individual help to all my problem students in the time it would take me to produce a program, and even then I wouldn't guarantee that the program would help. I look upon this programming, or authoring, what ever you call it, like writing a book. I mean, wouldn't it be stupid to have to write your own text book for your class. I rather use someone elses program. If it's no good, I won't use it. I'll look for another or wait until one is available. But I can't see myself spending all that time programming."

Appendix K

SUMMARY OF COMPUTER RECORDS ON CAI COURSE UTILIZATION

COMPUTER ASSISTED INSTRUCTION - FEBRUARY 1971

	NOVEMBER			DECEMBER - JANUARY			FEBRUARY		
COURSE NAME	STDHR	STD	SAMHR	STDHR	STD	SAMHR	STDHR	STD	SAMHR
baleqn	1.31	44	10.09	0.0	16	5.13	18.85	3	5.38
bioll				0.0	2	0.34	0.0	0	1.91
cai	6.65	9	73.19	4.17	2	10.95	0.0	0	89.74
calc	0.0	0	41.88	0.16	1	22.10	0.32	2	49.81
cangov				1.30	2	2.50	0.10	0	2.18
cellif				0.15	3	0.0	18.51	35	0.22
cetest							0.0	0	0.46
chemex	46.05	101	7.06	55.53	0	12.41	9.25	72	10.37
code	9.44	132	3.56	34.40	66	2.61	18.59	32	11.03
elecl0				0.02	1	0.14	0.0	0	1.19
eranl	0.0	2	6.20	0.27	0	20.04	0.82	3	2.24
equg				0.0	2	0.21	0.0	0	4.57
expo	1.03	91	0.51	0.72	16	0.65	3.47	3	1.52
factor							0.0	0	0.02
gaslaw	0.0	5	2.81	0.0	0	0.60	5.36	107	2.90
gent	0.08	3	0.50	0.57	1	3.95	1.26	3	5.35
geog				0.04	2	15.46	0.0	0	1.78
geoml0	0.0	4	0.29	0.0	0	0.13	0.05	1	0.53
hands	0.0	5	0.26	0.11	0	2.04	0.0	0	1.77
inan				1.39	2	2.37	0.0	0	1.19
info	5.54	0	0.0	8.99	0	0.0	7.04	0	0.0
intrac	6.15	1	5.10	20.49	0	6.60	4.46	70	10.87
irlang	1.43	1	7.55	0.0	3	5.20	0.53	2	11.59
jcl				0.0	1	11.18	2.14	7	11.32
linequ				0.0	2	40.63	0.0	0	0.33
logar	0.01	3	0.01	0.0	0	1.29	0.0	0	0.30
matheq	4.96	12	1.96	4.14	2	4.91	1.70	2	6.84
mathop				0.0	61	0.67	4.89	2	7.29
molell				0.09	4	38.47	0.01	1	0.31
mpl	10.54	3	3.76	0.47	1	1.64	5.47	0	13.93
naplon							0.02	1	0.01
ornom	9.95	5	7.95	0.0	0	1.30	3.21	5	9.69
shakes				0.0	2	0.07	0.24	0	1.47
shorst				0.0	1	0.22	0.0	0	0.40
sigfig	4.22	87	2.88	70.46	60	5.45	7.26	78	12.40
space	0.61	2	*	1.56	3	26.07	4.88	0	26.73
stock				0.14	1	0.28	0.24	0	0.24
tester							0.0	1	0.0
tic	0.52	1	0.46	0.59	2	6.20	0.93	0	5.86
trees	0.0	0	10.63	0.02	3	0.34	0.43	0	2.89
triang	0.0	1	0.96	0.43	3	1.88	4.50	110	6.30
util	0.50	3	2.16	0.24	1	1.16	0.75	2	3.52
watfor	1.75	17	5.89	66.96	5	7.03	9.28	28	12.97
TOTAL	111.02	533	195.66	271.91	278	251.97	134.56	570	339.42

STDHR - terminal hours used by registered students
STD - number of students registered
SAMHR - terminal hours used by sample student numbers (start, sample shand, skelo)

APPENDIX L

TABLE OF LOG BOOK ENTRIES CONSIDERED PERTINENT TO STUDY

Date	Event
July 7/70	Handsworth Coordinator and another teacher begin authoring.
Aug 17/70	First Handsworth terminal
Sept 3/70	Kelowna terminal shipped
Sept 15	Kelowna terminal up.
Oct 19	Priority system at Handsworth
Oct 15	Memo from Computing Centre re: Coursewriter III Version 2 test beginning Nov 15 for two hours each morning for two weeks.
Oct 17	Second Handsworth terminal operating.
Nov 9	Memo from Computing Centre re: if CAI crashes during the PM it will not be reinstated until after 6 PM.
Nov 15	Two week testing of Version 2 begins.
Dec 18	Computer shut down for five days to install new disk drives.
Jan 6/71	Version 2 operating
June 15	Kelowna Interviews and Questionnaire
June 17	Handsworth Interviews and Questionnaire

Appendix M

TABULATION OF QUESTIONNAIRE RESPONSES

QUESTIONNAIRE:
HANDSWORTH/KELOWNA CAI PROJECT
1971

Response Frequency

Handsworth listed first, N= 12
Kelowna listed second, N= 71

	A	B	C	D	E
1. My grade is: A) 12 B) 11 C) 10 D) Lower	2	5	5	0	
	10	60	1	0	
2. Each time I used CAI, the number of minutes I spent at the terminal was approximately:	A	B	C	D	E
A) less than 5 minutes B) 5 to 10 minutes C) 10 to 20 minutes D) 20 to 30 minutes E) 30 to 60 minutes	0	0	5	7	0
	8	5	18	27	13
Rate the following statements as to whether you A) agree B) partially agree C) undecided D) partially disagree E) disagree					
3. I found "INTRO" adequate for giving me instructions on how to use CAI.	4	5	0	3	0
	45	13	7	3	0
4. I found the Chemistry courses relevant to my studies.	9	3	0	0	0
	35	22	5	7	2
5. I could use the terminal(s) whenever I wished.	0	6	0	1	5
	4	11	5	19	32
6. I found that my timetable schedule allowed me to use the CAI system often.	8	4	0	0	0
	3	11	8	15	26
7. The student monitors were useful.	12	0	0	0	0
	39	18	5	4	5
8. I enjoyed using CAI.	11	1	0	0	0
	39	11	5	7	9

Appendix N

MEMO FROM COMPUTING CENTRE PERSONNEL
RE: CAI RE-INSTATING RESTRICTION

SIMON FRASER UNIVERSITY COMPUTER CENTRE

ACADEMIC SYSTEMS NOTE Ref: 0019

DATE: Nov. 10, 1970

SUBJECT: 1) COMPUTER USERS ADVISORY COMMITTEE
2) IBM AND B.C. TEL PRESENTATIONS
3) CAI HOURS

3. CAI Hours

Until further notice CAI will remain on after 2 p.m. unless it crashes between 2:00 and 6:00 p.m. If this occurs it will stay down until 6:00 p.m. at which time it resumes normal operation.

Nino Stroppa
Senior Academic Programmer

n.s:emw

Appendix O

EXAMPLES OF NEWSPAPER ARTICLES ON CAI PROJECT

Everybody's in love with teacher Irving

TORONTO GLOBE AND MAIL

NORTH VANCOUVER, B.C. (CP) — Irving, the talkative computer, is a lively teacher with a sense of humor.

At Handsworth S. S. in North Vancouver, the students really dig Irving and rely o... with p... try, pl... or biol...

Bob Johnston, chemistry teacher at Handsworth, said the students spend long periods of individual instruction with him.

"He's sort of a cross between mechanical programmed learning and a human teacher," said Mr.

Actu... in the ... ser U... away. ... two co... the No... by a ... line."

Hanc... port Ir... a lot ... doesn't ... fuse w... answe... him. H... better. ... praise:

A r... sage c... worth... warne...

"Yo... you g...

But ... and ... loaded ... tion.

Irving gives lesson in cybernetics

By WILF BENNETT
Province Education Reporter

Computer terminals may be installed in many schools in the near future, two B.C. edu...

2 Features

WINNIPEG FREE PRESS, SATURDAY, JANUARY

IRVING'S A LIVELY TEACHER

The talkative computer

NORTH VANCOUVER, B.C. (CP) — Irving, the talkative computer, is a lively teacher with a sense of humor.

At Handsworth secondary school in North Vancouver, the students are in love with Irving and rely on him when faced with problems in chemistry, physics, mathematics or biology.

Actually, Irving "lives" in the library at Simon Fraser University, 15 miles away. He is connected with two computer receivers in the North Vancouver school by a special "dedicated line."

Handsworth students told a reporter recently that Irving kids them along a lot and they like it. He doesn't get angry or blow a fuse when they give wrong answers to try to confuse him. He exhorts them to do better.

"Your name is mud if you goof!" warned Irving.

But aside from his quips and wisecracks Irving is loaded with useful information.

Bob Johnston, chemistry teacher at Handsworth, said the students spend long periods enjoying individual instruction with him.

"He's sort of a cross between mechanical programmed learning and a human teacher," said Mr. Johnston. "His process is known as computer-assisted instruction."

Students take questions on a variety of subjects to Irving, type them out, punch the "return" button and Irving replies immediately with the correct answers.

The school is planning to extend the use to English and French lessons shortly.

Each student is given a Two are always on duty.

Not only does Irving answer questions, but he can deliver a neatly typed mini-lecture in any of his subjects on call. He usually follows up with questions on the material and makes students keep repeating until they hit the correct answer.

If the student succeeds after several false starts, Irving will compliment him with "fantastic," "genius child," or some other commendation.

This is the first term of a one-year experimental program which costs the North Vancouver school board nothing. It is being financed by grants from International Business Machines and from the Educational Research Institute of B.C. with B.C. Telephone providing the "dedicated line" without charge.

Appendix P

EXAMPLE OF CAI COURSE "INTRO"

Welcome to CAI! This thing sitting typing in front of you is a TERMINAL. It is hooked up to me, Irving the Computer. Is this your first time on CAI? (Type in your answer then send it to me by hitting the carriage return key.)

***** yes

"intro"

Well, relax and enjoy yourself. I don't bite!

(If at any time you make a mistake typing, type:
///
and hit the carriage return. Then retype your answer.)
Are you male or female?

***** male

Rats! So am I. Can't win them all . . . anyhow, what is your first name?

***** gil

Well, Gil, CAI consists of a set of courses, each of which teaches or drills a different subject. You are now signed on to the course Intro, which explains how to use the CAI terminals. Now . . . were you paying attention to what I was typing? Quick, without looking -- what is the NAME of this COURSE?

***** introduction

I think you have it right, but I'm not sure. Type in the course name all by itself so I can tell for sure.

***** intro

Gil, you're right with it!

Now, to use CAI, the first step you take is to flick the ON-OFF switch (at the right hand side of the keyboard) to ON. Got that? What's the first step you take when you sit down at the terminal?

***** turn the thing on

Fantastic! By the way, if the moron before you left the terminal on, you may have to turn it off and on again to release the keyboard. Can you hear the click as I stop typing?

***** I might have if harold hadn't been making such a noise

Well, listen more closely next time, and you should be able to hear it. It is very faint, but audible. Now, the next step is to hit the carriage return to clear the terminal of the old messages. I will then type:

INVALID PREFIX
TYPE YOUR NUMBER

Okay, what do you do to clear the terminal?

***** hit the return

Appendix Q

EXAMPLE OF STUDENT INTERACTION USING "BALEQN"

```
Welcome to this course on balancing equations.  This course is
designed to enable you to master the technique of balancing equations.
In order that I can communicate with you more freely I would like to
know what do people ordinarily call you.
→ Gil

Well, Gil, this is a program on balancing chemical equations,
but first we must worry about oxidation numbers.
Do you know about oxidation numbers?  Type yes or no.
→ no

I think you had better review oxidation numbers with me, Gil.
The oxidation number is the charge which an atom
appears to have according to certain rules.
Let us review the rules for calculating oxidation numbers.
Rule 1.  In elements, atoms have oxidation number = zero.  So in these
examples do the atoms have oxidation number = zero (if so, type yes)
or not (type no).
Let us start off with Na(s).
(if you do not know what the little s in brackets means, type 'explain'.)
→ yes

Ok, how about magnesium atoms in MgSO4(s)?
Is the oxidation number for Mg = zero?
→ no

Ok, how about Mg(++)?  Is the oxidation number for Mg = 0?
Type yes or no.
→ no

Ok.  How about oxygen in H2O?  Is the oxidation number for oxygen = 0?
Type yes or no, please.
→ yes

Come on, is this stuff an element or not.  Read the rule and try again.
Is the oxidation number = zero?  Type yes or no.
→ no

Ok.  How about Hg(liquid)?
Is the oxidation number for Hg = 0?  Type yes or no.
→ yes

Ok, that was all correct, Gil.
Rule 2.  In simple ions (that is ions consisting of only one atom)
the oxidation number of the atom is equal to the charge on the ion.
The metals Li, Na, K, Rb and Cs are found only with oxidation
number = +1 in all their compounds.
Mg, Ca, Sr, Ba and Ra are found to be +2 in all their compounds.
What is the oxidation numbers of the atoms in these examples.
Type in + or - followed by a number.  Fe in Fe(+++).
→ +3
```

Appendix R

EXAMPLE OF COURSE IN AUTHORING LANGUAGE

```
THE LISTING FOR EXEC  -GO  27 4/71 BOB JOHNSTON      ::::::::::::::
 2-   6     LESS***  IT IS RATHER PROBABLE THAT YOU HAVE SEVERAL DOLLARS LE
 2-   7     SAY, MAYBE ONLY 999,989 DOLLARS.   IN THIS CASE YOU COULD STIL
 2-   8     A MILLIONAIRE, BUT TO THE PURIST, YOU WOULD HAVE 999,989 DOLLAR
 2-   9 TY B5*
 2-  10     , HOW WOULD YOU WRITE THIS EXACT NUMBER OF DOLLARS IN EXPONENT
 2-  11     (YOU CAN SEE THAT THERE IS GOING TO BE MANY MORE THAN ONE    >>
 2-  12     IN FRONT OF THE MULTIPLICATION SIGN, X).******
 2-  13 BR MILLIO*
 2-  14 UN PLEASE TYPE EITHER     PROCEED     OR      SIGN OFF    .******
 2-  15 NX       *
 2-  16 BR MILLIC*
MILLIO  **       *
 1-   0 JU REMEMBER TO USE THE TWO ASTERISKS (**) TO SHOW THE POWER.*****
 1-   1     ALSO, USE A LOWER CASE +X+ TO SHOW THE +TIMES+ SIGN, BEFOR THE
 1-   2 CA THE CORRECT ANSWER IS 9.99989X10**5, ISN'T IT*  HOWCUM YOU NVEI
 1-   3 CB 9.99989X1C885*
 1-   4 CB 9.99989X10**5 DOLLARS*
 1-   5 CB(L) 9.99989&X&10**5&*
 1-   6 TY TERRIFIC*  NOW, MAYBE YOU'RE BEGINNING TO SEE WHAT WE'RE GETTI
 1-   7 BR EOMILL*
 1-   8 WA(L) &L&*
 1-   9 TY LOOK OUT FOR THAT LETTER 'EL', WHICH YOU MAY HAVE USED INSTEAD
 1-  10     THE NUMERAL +ONE+.  TRY AGAIN.******
 1-  11 CA(L) 9.99989&X&10**&*
 1-  12 TY CHECK YOUR EXPONENT, AND TRY AGAIN.******
 1-  13 BR MILLIC*
 1-  14 WA(L) &.9989X10**4*
 1-  15 WB(L) &.9899&X&10**3&*
 1-  16 TY OUCH*. *  DID YOU FORGET OUR CONVENTION WHICH SAYS ONLY ONE DI
 1-  17     ******
 1-  18     BE PLACED IN FRONT OF THE DECIMAL.***REPEAT, PLEASE.******
 1-  19 WA(L) &X&10**5*
 1-  20 TY SOMETHING GARBELED WITH THE NUMERALS IN FRONT, I THINK. CHECK
 1-  21     DIGITS AND TRY AGAIN, *
 1-  22 TY B5*
 1-  23     .******
 1-  24     ALSO, WOULD YOU CHECK TO SEE IF YOUR PLACEMENT OF THE DECIMAL I
 1-  25     THE RAISED POWER NUMBER.  I'LL WAIT A FEW SECONDS (ABOUT 7), TI
 1-  26     ANSWER ANY TIME AFTER YOU HEAR ME CLICK MY TONGUE.)******
 1-  27 PA 7*
 1-  28 WA(L) 9.99989&X&10&5*
 1-  29 TY ARE YOU SURE YOU USED THE TWO ASTERISKS (**).  CHECK, AND TRY
 1-  30 WA(L) &1&X&10**6&*
 1-  31 TY LOOK AT THE SECOND PART OF THE QUESTION, WHERE WE ARE ASKING A
 1-  32     THE NUMBER 999,989 DOLLARS, NOT THE FULL MILLION, AND TRY AGAI
 1-  33 UN CAN'T READ THAT.  AN ERROR SOMEWHERE.  LET'S BOTH TRY AGAIN.**
 1-  34 UN STILL CAN'T READ YOU.  TRY AGAIN, BUT BE SURE WE'RE ON THE SAM
 1-  35 UN LAST CALL***  GET IT RIGHT THIS TIME OR I SIGN OFF*******
 1-  36 NX       *
EOMILL  **       *
 1-   0 PR       *
 1-   1 TY SUPPOSE YOU DID HAVE EXACTLY       >>>>>>> ONE MILLION DOLLARS
 1-   2     MORE OR ONE PENNY LESS.   HOW WOULD YOU WRITE THIS NUMBER NOW.*
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Appendix S

SCALE OF APPROPRIATENESS-INAPPROPRIATENESS
(Example of scale developed for teacher interview)

Scale of appropriateness applied to interview data responses

Positive	Neutral	Negative
Appropriate:		
6	0	0
5	1	0
5	0	1
4	2	0
4	1	1
4	0	2
3	3	0
Marginally Appropriate		
3	2	1
3	1	2
3	0	3
2	4	0
Inappropriate		
2	3	1
2	2	2
2	1	3
2	0	4
1	5	0
1	4	1
1	3	2
1	2	3
1	1	4
0	6	0
0	5	1
0	4	2
0	3	3
0	2	4
0	1	5
0	0	6