IMPLEMENTATION OF MICROCOMPUTERS IN
ELEMENTARY SCHOOLS: A SURVEY AND EVALUATION

by

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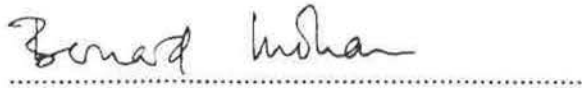B.A., Stanford University, 1977

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Abstract

The objective of this thesis is to investigate the uses of computer aided learning (CAL) at the elementary level. Some recent publications on CAL are summarized and discussed. A questionnaire was used and interviews were conducted with elementary teachers in four chosen school districts in Vancouver and Toronto. From this field research, information was collected on teachers' perceptions on the use of CAL in the elementary classroom. This data is compared with observations presented in the relevant literature, and the comparison discussed within Robert Taylor's framework of using the computer as tutor, tool, and tutee. Included are the results from the questionnaire. The thesis concludes with a discussion on the role of the teacher in the use of computers in the classroom, a flexible approach to adopting CAL, and possible areas for future research.

Table of Contents

List of Tables

List of Figures

Acknowledgements

Chapter 1.

Introduction

The microcomputer is fast becoming an indispensable tool in many sectors of society. If people are to function to their full capacity in this computer age, it is increasingly important to become computer literate. Joseph I. Lipson, of the Division of Science Education Development and Research from the National Science Foundation in Washington, D.C., concluded his talk to the Third Canadian Symposium on Instructional Technology in 1980 saying,

> It is my belief, my expectation for the future that computer based education will be essential to the kind of learning we will need to understand our world, to compete in the world we are moving towards, to survive and to sustain freedom (Lipson, p.450, 1980).

But should computer-based education begin at the elementary level? One computer-using teacher has commented that the amount of computer experience an elementary student obtains in the few years of schooling could be gained within 10 hours of instruction when he enters high school. If this is indeed the case, it may be educationally more productive to concentrate the machines at the secondary schools. To do so, however, seems more like a temporary solution to the problem of insufficient hardware at secondary schools. In the long run, as the demand for computer courses in post-secondary institutions increases, the degree of difficulty of computer science courses at college will correspondingly escalate. To better prepare students for the competition, instructional computer uses and computer science courses at the high school level will become more popular. Similarly, elementary

school students who have had more exposure to instructional computer uses will be at an advantage. Therefore, in an ideal situation, expansion of computer uses at elementary schools is an inevitable trend. Whether this ideal case can in fact become reality is another question. In any case, the present study assumes increased use of computers to be educationally beneficial to elementary students.

A precondition to implementing computer-based education is a sufficient number of computers. According to a survey done in 1984, there were a total of 28,377 computers in all the provinces across Canada (see Table 1.1). With the enrollment of students estimated at 4,800,160, to achieve the situation of one computer for every 10 students, 451,639 more computers would be needed. This was estimated to cost about $1 billion (Allan, p.19, 1984b).

Province	Number in 1984	Number in 1983	Percent Increase
Ont.	9000	8000	12.5
Alb.	6000	3535	70
B.C.[a]	5317	2889	83.4
Sask.	2000	1500	33
Man.	1610[b]	1610	-
Que.	1500	800	86
N.B.	1250	1000	25
N.S.	1000	800	25
Nfld.	500	200	150
PEI	200	150	33
Total	28,377	20,484	39

Table 1.1 Numbers of Computers in Canadian Provinces.

[a]The numbers for B.C. have been taken from Flodin's survey (Flodin, p.6-9, 1984); the original numbers in Allan's survey are less: 2500 in 1983, 3800 in 1984, and with a percentage increase of 52 (Allan, p.19, 1984b). The totals are correspondingly adjusted.

[b]Based on a year old survey; a new survey is currently being compiled and will not be available until well after press time (Allan, p.19, 1984b).

It is apparent that the current instructional use of computers is far from optimum. To ask the question whether instructional computer use is effective at this stage is premature. Instead, this study attempts to shed light upon the current state of interactions among the teacher, students, and computers within the context of the classroom. It will address issues such as the amount of access students have on computers, and actual use of the software in the classroom. Different kinds of software will be discussed and evaluated. This understanding will hopefully help teachers improve upon instructional computer use in their classrooms.

Chapter two introduces the terminology and reviews and summarizes some background literature. Chapter three is an analysis of the results from the questionnaire, which paints a sketch of the current state of computer use in the elementary classroom. Chapter four and five discuss computer-aided learning within the framework advanced by Robert Taylor. Chapter four investigates using the computer as tutor while chapter five continues the inquiry and studies the function of the computer as tool and tutee. The last chapter consists of summary, recommendations and conclusions.

Chapter 2.

Terminology and Background Literature

2.1 Terminology and Classifications

The roles that computers can play in education fall into two main categories, computer-assisted learning and computer-managed instruction.

Computer-assisted learning (CAL) includes all of the instructional uses of computers, from teaching computer science to Canadian history, from studying the anatomy of a frog to typing essays.

Computer-managed instruction (CMI) is the administrative uses of computers. CMI therefore refers to all the varied uses of computers which indirectly contribute to the educational process, such as maintaining student records or monitoring their achievements.

This study concentrates only on CAL. CAL includes both learning through computers and learning with computers. The former usage is termed computer-assisted instruction (CAI), which has meant "the presentation of lesson material and questions on that material through a computer terminal (or more recently a microcomputer), with the student responding to the computer as the questions are presented" (Ragsdale, p.22, 1982).

Different schemes exist to classify the various types of CAL. This study adopts a functional scheme. Robert P. Taylor suggests all instructional uses of computers fall under three modes: tutor, tool, and tutee (Taylor,1980).

As tutor, the computer is made to fit into the educational paradigm. The student is "taught knowledge" by the computer (Fogel, 1983). As a tool, the computer assists the student in the learning process but does not direct his efforts. A ready example is to use the computer as a word processor. As a tutee, the student "teaches" the computer. For example, he programs the computer to draw a house. To do so, he must himself understand how to draw a house. According to this scheme then, learning through computers is using the computer in the tutor mode, and learning with computers is using the computer in either the tool or tutee mode.

Before turning to a discussion of uses of the computer in the classroom, we shall first review some of the terms used in this study (Fogel, 1983).

(1) Computer-Assisted Instruction (CAI) - The computer takes over some or all of the instruction of the student. Programs range from simple drill and practice exercises, to simulation and tutorial programs which can respond in different ways to student input.

(2) Computer Literacy - Preparing students for the use of computers in society, and discussing their social impact.

(3) Computer Science Instruction - Teaching of programming, systems architecture, design, and applications etc.

CAI can be further subdivided into the following types of software:

[1] Drill-and-practice - This program usually involves a linear presentation of lessons or exercises which varies slightly if at all for individual students. Questions might be selected in random order, for example. Typically, no new material is covered in drill and practice; that is left to the teacher. The

computer simply provides practice and drills on a topic, and students obtain immediate feedback on their performance.

[2] Tutorial - Lessons are presented to the student in the form of text and questions. The student can switch to another part of the program or to a review section, depending on his progress. New materials are presented in the program in a fixed, though flexible, format.

[3] Simulation - The program is designed to model complex systems which cannot be brought into the classroom. Through text, graphics and questions, students gain some "pseudo-experience" in the microworld under investigation, which may be a river ecology, an airplane control system, or the anatomy of a frog.

Simulation is more flexible than a tutorial for it must be able to respond to a broad range of student input.

The three kinds of CAI software will be discussed further in chapter four. First, we will begin with a review of some of the relevant literature.

2.2 Background Literature

This study focuses on current implementations of computer-based education in the elementary classroom. The need for such an investigation has been suggested by several studies done in Canada, which include one conducted by the Ontario Ministry of Education and two in British Columbia. This chapter reviews these studies, and also summarizes findings from two studies done in the United States, which provide interesting points of reference and contrast to the Canadian inquiries.

2.2.1 A Rand Note

Richard J. Shavelson et al.'s penetrating study, "Successful Teachers' Patterns of Micro Computer-Based Mathematics and Science Instruction" (1984), isolates three factors which are deemed to be mainly responsible for limiting the potential contribution of computers to education. First, the unavailability of hardware; second, a lack of knowledge about instructional uses of computers; and third, a shortage of high-quality instructional software (or courseware) to accompany local curricula. Their study attempts to close the knowledge gap in the field by addressing the second and third factors.

A basic premise upon which Shavelson et al. have based their study is "that computer use fits within teachers' ongoing planning and decision making process" (Shavelson et al., p.24, 1984). Based on this assumption, Shavelson et al. have investigated methods whereby successful computer-using teachers in California implement the technology in their classrooms. The methods fall into four clusters: *orchestration, enrichment, adjunct-instruction,* and *drill and practice*. The characteristics of these successful teachers and of the district, school and classroom contexts in which they work are described.

Through this investigation, Shavelson et al. have gathered these exemplary teachers' recommendations about staff development and courseware design, which are compared and juxtaposed with the theories and suggestions found in current literature. Moreover, many instructional decisions and practices of the teachers are summarized. These serve as valuable points of reference for the present study.

The assumption that computers fit into teachers' ongoing planning and decision-making process does not coincide with many teachers' actual experiences. In fact, lack of integration of computer technology into the curriculum has been suggested as the most critical obstacle to the further expansion of educational technology in schools. As the study by the Bank Street College of Education indicates, teachers often find integration of computers into their classrooms to be a major problem.

2.2.2 Study by Bank Street College of Education

Entitled "Study of Issues Related to Implementation of Computer Technology In Schools" (Sheingold et al., 1981), this exploratory study investigates computer instruction at schools in three locations: a large southern city, a midwestern urban school district, and a small suburban community in the northeast of the United States. The inquiry adopts a case-study approach. At each site, interviews have been conducted at four levels: *the community level, the school administrative level, the classroom level,* and at *the individual teacher and student level.*

From the interviews, a number of issues are identified as the most pressing questions if computer instruction at that location is to be improved. Finally, six cross-site questions emerge as pertinent research issues. They are briefly discussed below.

1. The differential access to microcomputers

Differential access to microcomputers has been observed among students of different abilities. At some elementary schools, low ability students have access to the machines for extra drill and practice. Consequently, a stigma is attached to using the machines and one teacher has "refused to have any in his classroom as a result" (Sheingold et al., p.101, 1981).

Sex differences also account for differential access to computers. Starting at grade seven, there is much greater male representation among students who use microcomputers (Sheingold et al., p.101, 1981).

2. The emergence of new roles in response to microcomputers

Two new roles in addition to the traditional models of the wise teacher and respectful student have been observed to emerge: *teacher buffs* and *student experts*. Teacher buffs are defined as those "who are not only interested in and knowledgeable about microcomputers, but play a central role in spreading the innovation" (Sheingold, p.102, 1981). The study suggests these teacher buffs constitute a necessary component of any innovation and that they should become institutionalized. Usually, they are removed from the schools and become consultants at the local school boards.

Student experts introduce some changes into the traditional hierarchical relationship between the teacher and students in a classroom. They instruct their teachers and fellow classmates about computers. The study also suggests student experts may make demands upon the school system for curriculum changes which would accommodate their high interests in the new technology. However, such a development seems unlikely. A more modest demand by students which the present

investigation has revealed is that made on the teacher rather than on the system. Teachers reported students embarrassed them into learning more about the computer when the latter repeatedly asked questions the teachers could not answer.

3. The lack of integration in elementary classrooms and curriculum

The study acknowledges the relationship of the microcomputer to the curriculum to be one of the most complex issues but it fails to conclusively analyze this question. Instead, it suggests viewing this issue in a different perspective. In schools where computers are not physically inside the classroom, the work students do on the computers may share the same objectives of that which they do in the class. The question then remains whether children can relate their work on the computers to that done in the classrooms. In other words, is there any transfer of knowledge acquired from one medium to another (Sheingold, p.104, 1981)? Integration of computers into the curriculum is interpreted to mean conceptual and cognitive integration by students.

The study explains the emphasis on the integration of computers into the curriculum as having "stemmed from our assumption that such integration was a measure of the impact of the microcomputer" (Sheingold, p.105, 1981). Impact of microcomputers is difficult to quantify. This focus on integration can perhaps be better explained by acknowledging the fact that it is only when teachers see microcomputers as an integral part of curricula and classrooms would they readily adopt the new technology. So while this study is right in pinpointing integration as the most complex issue, the rationale given for its significance is debatable.

The extent of integration at present is at best limited. It is observed that "the site in which microcomputers were in elementary classrooms is also where there were buffs," and that "such integration is likely to take place only if classroom teachers actively work towards it" (Sheingold, p.104, 1981).

While the curriculum remains unaltered with the advent of microcomputers, what is observed to have changed is the organization within classrooms: "many teachers indicated that classroom use of microcomputers resulted in a more individualized relationship between teacher and student, and less whole group teaching" (Sheingold, p.105, 1981).

These findings serve as interesting points of reference for the present inquiry.

4. Inadequate quantity and quality of software

The study lists three factors as contributing to wider usage of software by teachers: accompanying instructions for software, comprehensive whole units of software, and teachers' input into the design of software. Then it suggests research needs to be done on how ideas can be realized in the software medium, and how different types of software meet different educational goals and purposes and relate to different outcomes (Sheingold, p.107, 1981).

5. The inadequate preparation of teachers for using microcomputers

Despite the availability of inservice courses, opportunities to study at nearby colleges and universities, and helpful teachers or resource personnel, teachers still feel inadequately prepared to use microcomputers in classrooms. Their request, however, is not for more courses or inservice-training, but "more time to use the machines, to

review available software and plan for its use in the classroom" (Sheingold, p.107, 1981). Furthermore, teachers also need time to observe how their students interact with computers so they could access how the machines could be used. In other words, teachers want time to acquire the experience of actually using the machines with their students. Time is the critical factor.

The study suggests a flexible approach of matching the level of training with teachers' expertise and interest. To implement this kind of individualized training, the availability of a teacher buff at each school is indispensable. Lastly, it suggests that principals should accommodate teachers' needs to learn about computers.

The suggestions are no doubt a reflection of teachers' collective opinions, and can be compared to the recommendations made by teachers in California (Shavelson et al., 1984).

6. Lack of knowledge of effects and outcomes

Teachers have commented on the social outcomes of students' interactions with computers in terms of self-esteem and social status but no one has made any conclusive comment about academic effectiveness. Both academic and social effectiveness are areas that deserve further study.

The inquiry points to the presence of an implicit assumption among teachers that "were one to measure outcomes, they would be positive" (Sheingold et al., p.109, 1981). Needless to say, such outcomes are difficult to measure. Furthermore, the important question at this stage is not whether the outcomes are positive for "microcomputers per se will not promote particular outcomes". The more important question is how can instruction be improved with use of computers. As the study

concludes,

> Their impact will depend not only on hardware and software, but on how they are used and on the educational context within which they are embedded (Sheingold et al., p.102, 1981).

It is not a matter of outcomes, but methodology. The need for further research on the methods of instructional computer use is again substantiated by studies done in Ontario and British Columbia.

2.2.3. Study by the Ontario Ministry of Education

In 1982, the Ministry of Education in Ontario conducted a study on "the Impact of Microcomputers in Elementary Education" (Larter et al., 1983). The study aims to "contribute to an understanding of the impact that computers are having on education in order to explain, predict, and control this impact" (Larter & Fitzerald, p.1, 1983). Questionnaires were sent to principals of 118 elementary schools in September of 1982, and interviews were conducted with administrative personnel, teachers, and principals of the schools.

The survey results establish a rough outline of the state of instructional computer use in Toronto. 115 schools responded to the questionnaire; altogether they had 308 machines, with more than half possessing only one or two. Three quarters of the schools obtained their first machines in 1981 or 1982 and they were mostly Commodore[1] products (Larter et al., p.5, 1983). 33% of the machines were located in one classroom, 19% at a central site from which they were moved to different classrooms and 13% in a laboratory. The predominant use of computers in

Ontario schools was for programming, as 37% of the respondents listed this as the first usage. 31% used it for remedial work, 26% for drill and practice, 25% for games, and 24% for enrichment.[2] From the list of usages, it can be seen that the computer has not been integrated into the curriculum; instead, it is used as "an end in itself or as an aid for teachers, who may use it to provide remediation or drill but who themselves undertake the main work of teaching" (Larter et al., p.15, 1983). Computers are mostly under the control of individual classroom teachers.

Instead of adopting a case study approach, the Ontario study attempts to classify the implementation of microcomputers in education in elementary schools into 4 types of preparedness contexts. These contexts are established as a means to relate variables such as staffs', students', and parents' proficiencies with computers; or, as Larter and Fitzgerald put it, "as hypotheses about the relationships between variables that might explain the introduction of microcomputer in Ontario schools" (Larter et al., p.100, 1983). While these contexts seem arbitrary, the information presented within them is valuable.

The study adopts a sociological approach and discusses student interactions and socializations, new emerging roles for student experts, and changing relationships between teachers and students. Its emphasis on students is indicated in its discourse on topics such as the types of students most suited to using computers, their age range, and whether they should work in pairs or alone. Furthermore, it discusses how computers can be effectively used as a motivator and in developing hand-eye coordination, discipline, thinking speed, problem solving skills, visual memory, etc.

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[1]Commodore is a trademark of Commodore Business Machines Limited.

[2]The total percentage exceeds a hundred, indicating several usages are employed at a school.

All these observations serve as valuable points of comparison for the present study.

Similar to the Rand Note and the study by the Bank Street College of Education, the Ontario study acknowledges existing problems in the field to be the lack of trained teachers, the lack of quality software, and insufficient hardware. While listing sources of support available to Ontario teachers in their implementation of computers in classrooms, it also reflects the teachers' request to the Toronto Board of Education for increased guidance and support.

In its conclusion, the study suggests issues for future research to include: evaluation of effectiveness of different types of educational software, ways to improve integration of computers into the curriculum, how different types of pupils benefit from use of computers, and a clarification of the motivational property of computers for an exposition of the "attraction of the microcomputer for different types of students would be helpful in the design of software" (Larter & Fitzgerald, p.101, 1983).

2.2.4 British Columbia Studies

In the years 1983 and 1984, two inquiries were made into the state of instructional computer use in the public school system of British Columbia. Both studies involved a survey of computer use on the district level. Questionnaires were distributed to district personnel and the results tabulated.

2.2.4.1. Study by Education Department of Simon Fraser University

This 1983 study provides a "snapshot" of computer use in education. 74 of the 75 districts in the province responded. According to this survey, British Columbia had a total of 2889 computers, including those in both secondary and elementary schools. 65% of the computers were Apple II's.[3] Of the 948 elementary schools, 489 had no computers, 340 had one, 117 had between 2 and 5, and 2 had more than 6. Not surprisingly, the average ratio of students to a computer was well over 100.

Given the dearth of machines, it is understandable that the principal usage has been for computer literacy. The results indeed confirm that about 44% of the respondents have used computers for introducing computer literacy, about 20% have used them for compensatory-remedial activities, about 18% for basic academic skills, and about 12% for enrichment (Jones et al., p.18, 1983). The main curriculum areas in which computers have been used are mathematics and computer literacy.

The study is valuable as the first province-wide inquiry into the extent to which computers have infiltrated, or not infiltrated, the British Columbia public school system. Furthermore, it suggests actual implementation of computers in the classroom and benefits students derive from this use to be fruitful areas of research (Jones et al., p.15, 1983).

2.2.4.2. Study by British Columbia Teachers' Federation in 1984

This inquiry provides a more complete and current picture of computer uses in public schools. Compared to 1983, the number of computers has increased to 5317, and the ratio of students per computer has dropped to 76.0 to 1. Both figures attest to quite a substantial increase in hardware in the province (Flodin, p.9, 1984).

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[3]Apple II is a trademark of Apple Computer, Inc.

This study makes a more thorough investigation into the scope and form of inservice provided by the districts. It also gives a macro view of microcomputer use in the districts in terms of teachers' familiarity with the machines, curriculum areas in which computer applications have been adopted, and common usages of the machines.

	1983	1984
Number of computers[a]	2889	5317
Ratio of students per computer	436.4	76.0
Areas most used in elementary schools	computer literacy, remediation, basic skills, enrichment	computer literacy, remediation, instructional supplement, enrichment
Curricular areas most used in elementary schools	language arts & mathematics	language arts & mathematics

Table 2.1   Growth in Computer Usage in B.C. Schools.

[a]District totals include both secondary and elementary schools (Flodin, p.6-9, 1984). Ratio of students per computer are calculated with these numbers.

From Table 2.1, it can be seen that aside from the increase in hardware, the usage of computers in schools has remained basically unchanged. Computer literacy has continued to be the predominant mode of use, which indicates instructional computer use in British Columbia to be still in its infancy.

In contrast to the three factors limiting the growth of instructional computer uses suggested in the Rand Note (Shavelson et al., 1984), this study reports that teachers have pinpointed the three most vital issues facing educational computer uses

to be: first, the need to integrate computers into the curriculum; second, the need for provincial guidance on computer uses and related questions; and third, the necessity to correct the current undersupply of machines (Flodin, p.34, 1984).

Similar to the 1983 study, this inquiry acknowledges the urgent need for teacher inservice training. It further suggests that implementation of computer instruction within the contexts of the school and the classroom to be fruitful areas of research: no information exists on how easy it is for a student to gain access to a computer. Similarly, little information exists on the uses students are making of computers. There needs to be, as well, more careful and thorough evaluation of computer activities in schools. Which kind is most beneficial? Finally, a great deal of work and study must be done to determine how computer usages can be expanded into curriculum areas relatively untouched today, such as fine arts, social studies, physical education, etc (Flodin, p.36, 1984).

2.3 Conclusions

The five studies examined in this chapter have suggested many areas of research: student access to computers, social roles that have emerged consequent to computer introduction, possibilities of integrating computer technology into the curriculum, quantity and quality of software, effects of different CAL software, sex differences in computer use, methods of implementing computer-based education, etc. Not all areas will be discussed here.

The present study first attempts to understand current computer usage in the elementary classroom. Within this context, it investigates such issues as student

access to computers, software employed, students' interactions with computers, and effects of different kinds of CAL software. A more in depth discussion and evaluation of the software will suggest ways to improve integration of computer instruction into the curriculum.

Chapter 3.

Computer Use in the Elementary Classroom

3.1. Introduction

In order to investigate current computer uses in the elementary classroom, a questionnaire was used and interviews conducted to gather information on teachers' perceptions of the present state of computer usage at schools. Letters seeking permissions to conduct research were mailed out in June of 1984 to different school districts in British Columbia and Ontario. Vancouver and its vicinities were chosen because the researcher was a student at the University of British Columbia, completing this research for a thesis in partial fulfillment of the requirements for a master's degree in Computer Science. An understanding of computer usage in schools in Toronto serves as interesting contrast since the computer industry in Ontario is much more advanced than that in British Columbia.

Four school districts: West Vancouver, North Vancouver, Burnaby in British Columbia, and Scarborough in Ontario granted permissions in time for the researcher to complete her interviews and survey by March of 1985. Thus, the criteria for district selection were primarily convenience and board permission.

3.2. Method of Research

The researcher established initial contact with each district board through its resident computer consultant. After gaining a general understanding of computer

usage in schools in that district, the researcher then obtained a list of computer contact persons at individual schools. A contact or resource person is a more experienced practitioner of computer instruction who serves as the liaison person between a school and its district board. Except for Burnaby where schools were selected upon recommendation of the district consultant, random samples of schools were chosen from the lists obtained. Interviews with the computer contact person at the schools were arranged over the telephone. Each interview lasted about an hour, after which the researcher left the interviewee with a questionnaire. The questionnaire was either picked up by or mailed back to the researcher.

A sampling of non-computer contact persons were also chosen in North Vancouver. Initially, they were chosen to provide contrasting viewpoints to those offered by the contact persons. After interviewing 7 to 8 non-contact persons, however, the researcher discovered their viewpoints to range from outright disgust with the "non-humanitarian" computer to an eager interest in this new technology, which they felt would demand too much of their time should they attempt to learn it. Some of these interviewed non-contact persons completed questionnaires also. Hence the results from the questionnaires represent diverse opinions, from teachers who have never used the computer in their lessons to district consultants who train instructors to use computers in classrooms. In view of the fact that mostly computer contact persons responded on the questionnaire, the results represent the opinions not of the average elementary school teacher, but of teachers in favor and capable of using computers in their teaching. Furthermore, since the Burnaby schools were chosen because of their relatively higher usage of computers, the results are biased towards schools more advanced in computer uses than the average.

3.3. Summary of Results from Questionniares

A total of 66 questionnaires were returned from the four districts. Since teachers were explicitly informed they had the right to refuse to answer any question, not all questions were answered by everyone.

Results from the survey pertaining to some issues are presented below. Availabilities of hardware and software and competent staff are prerequisites to introducing computer instruction. Hence, results elicited from questions addressing these topics are discussed first. Since student access to computers is an issue that awaits research, results on this topic will be presented. Then, teachers' perceptions on various aspects of students' interaction with computers will follow. Results from questions on specific effects of CAL will be discussed in the next chapter.

3.3.1. Availability of Hardware and Software at Schools

85% of the schools (56 out of 66) had their first computers in the years between 1981 and 1984; in most instances, teachers initiated computer instruction at their schools (Questions II.1, VI.4 in Appendix A).

Years	# of schools	% of schools
71–75	1	1.5
76–80	8	12
81–84	56	85
No answer	1	1.5
Total	66	

Table 3.1. Year of Computer Introduction.

Initiated by	# of schools	% of schools
Teachers	26	39
School authorities	14	21
Both teachers & school authorities	21	32
Parent groups	2	3
No answer	3	5
Total	66	

Table 3.2. Initiation of Computer Instruction.

When asked if the introduction of computers into the schools was welcomed by teachers, students, parents, and school authorities, the response was overwhelmingly positive for the latter 3 categories. Some reservation can be detected among the teachers when 7 out of the 66 respondents indicated only "some" teachers welcomed the computer and 2 replied negatively. One teacher commented "20% don't welcome" and another, "2 to 1 yes" (Question V.2).

Of the 58 schools which replied to the question on the number of microcomputers available in their schools, 15 schools have 5 microcomputers, 13 have 4, 9 have 2, and 7 have 3. A table showing the distribution of hardware follows (Question II.2).

# of micros	# of schools	% of schools
1	4	6.90
2	9	15.52
3	7	12.07
4	13	22.41
5	15	25.86
6	2	3.45
7	0	0.00
8	1	1.72
9	0	0.00
10	1	1.72
11	0	0.00
12	0	0.00
13	2	3.45
14	0	0.00
15	0	0.00
16	3	5.17
17	0	0.00
18	0	0.00
19	0	0.00
20	1	1.72
Total	58	

Table 3.3. Distribution of Computers.

At the school with 20 computers, 15 are VIC 20's[1], and 5 Commodore 64's. Most schools have either Commodore 64's or Apple II's; some have both. The next most popular computers are Apple Compatibles and PET's[2], and 2 schools have over 10 VIC 20's.

The choice of hardware used at the schools was primarily made by the district boards. In some districts, the board either gave out a first microcomputer to each school or distributed a sum of "seed-money" to encourage them to buy a first computer. Machines were then bought with funds raised by the schools. Board

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[1]VIC 20 is a trademark of Commodore Business Machines Ltd.

[2]PET is also a trademark of Commodore Business Machines Ltd.

decisions on machines depended on a number of factors. The prices of the machines must be reasonable enough to enable wider accessibility to students. Durability and capability of the machines to run appropriate software and low maintenance overhead were considered. In the long run, future expandability of the computers, and future availability of good software for the machines were also factors deserving attention (Question II.9).

The choice of software is more flexible. In British Columbia, the Provincial Educational Media Centre (PEMC) distributed software evaluations on a regular basis. In addition, district boards also supply lists of suggested software, which have been compiled by teachers and board consultants after software previews. Guided by the lists, the teachers can then select software based on a number of criteria. Some criteria reported on the questionnaire are listed as follows:

- curriculum as basic criteria for software selection; for example, in North Vancouver, software is developed to suit the needs of the District 44 Writing Program; similarly, in Scarborough, software is being developed to meet curriculum needs in different areas;

- cost, usefulness at many grade levels; one teacher commented that a simulation program was deemed overly expensive and given up for a simple drill in game format program despite the fact that students were more interested in simulation programs;

- appropriateness of instructional level;

- adaptability of program to individual needs:

   – sensible use of graphics;

   – ease of use by students as only small groups can use a machine at a time and there is no group teaching available;

   – ability to challenge and stimulate students and to develop thinking skills, e.g. logical programs like Moptown, Snooper Trooper;

   – individual student's needs for drill and practice;

   – computer as a tool software, e.g., word processing and spreadsheet software;

The most widely-used software is LOGO; 53 out of the 63 respondents cited this as the main piece of software used. Its use ranges from kindergarten to grade 7, with the primary grades adopting the simplified version, E-Z LOGO, and the higher grades, LOGO. The next most widely-used piece of software is Bank Street Writer; it is used in about half of the schools visited. While most schools use it in grades 4 to 7, it is also used in several schools in the lower grades. Other software which enjoy over 10% usage are shown in the following table (Question II.3).

Software	# of schools (out of 63)	% of schools
LOGO	53	84
Bank St. Writer	32	51
Milliken Math.	23	37
Moptown	21	33
MECC Lang.Arts	19	30
Houghton Mifflin	25	40
Koalo Pad	17	27
Rocky's Boots	14	22
Fay That Math. Woman	13	21
Factory	11	17
Kidwriter	10	16
Mastertype	9	14
MAC 4,5,6	7	11

Table 3.4. Software Usage.

3.3.2. Background of Interviewed Teachers and Their Perceptions

The majority of the teachers interviewed have taught for over 16 years. Of the 66 teachers who returned the questionnaire, except for one who has taught only one to three years, all the rest have taught for over 4 years. Their majors in college were predominantly in the arts (Questions 1.1, 1.2).

Years taught	# of teachers	% of teachers
1- 3	1	2
4- 6	9	14
7- 9	7	11
10-12	10	15
13-15	14	21
16 or more	25	38
Total	66	

Table 3.5. Teachers' Years of Experience.

Major	# of teachers	Rounded % of teachers
Arts	50	75.8
Science	11	16.7
Reading Education	1	1.5
Education	1	1.5
Library	1	1.5
Community school coordinator	1	1.5
No answer	1	1.5
Total	66	

Table 3.6. Teachers' Academic Background.

The teachers' academic backgrounds may well explain the result on another question. When asked if the teachers develop any of their own software, of the 60 respondents, 53 replied negatively and 7 affirmatively (Question II.5).

Teachers' perceptions concerning external support are reflected in their unanimous agreement on the need for greater government funding and greater co-operation among schools or school boards. The latter opinion was expressed despite their awareness that some inter-school or inter-school board communication on the selection of CAL software already existed (Questions VI.2, VI.3, II.15).

	Yes	No	Some	Don't know	No answer
Increased government funding necessary	55	1	0	5	5
Is there inter-school or inter-school board communication on the selection of CAL software?	45	9	7	2	3
Need for greater co-operation among different schools or school boards.	43	5	0	13	5

Table 3.7. External Support For Schools.

Teachers were in general not familiar with the hardware used. 20 out of 66 respondents did not know how to respond to the question on the machines preferred in implementing computer instruction. 28 favored microcomputers and 12 would like to have access to a computer network (Question VI.1). When asked if there are remote connections of computer systems to those elsewhere, only one reported a modem was used (Question II.7).

Remote connection of computer systems?	Number	Rounded %
Yes	5	8
No	47	71
Don't know	6	9
Modem used	1	2
No answer	7	11
Total	66	

Table 3.8. Hardware Characteristic.

Teachers value computer instruction for different reasons. The most predominant objectives teachers attempt to achieve with it are individualized instruction. computer literacy, and improving teaching effectiveness (Question II.8). Their preference on a checklist of objectives are tabulated as follows:

Teachers' objectives	# of teachers
Individualized instruction	40
Computer literacy	33
Improving teaching effectiveness	30
Mastery of learning	25
Word processing	23
Work on computer as reward	11
Just to occupy the students	7
Reinforce drills (esp. in math.)	1
Alternative for problem students	1

Table 3.9. Teachers' Objectives in Computer Instruction.

The subjects in which computer instruction is most widely used are language arts and mathematics. Since computers may be simultaneously employed in several subjects, considerable overlap in the number of teachers who adopted them in each subject can be expected (Question II.10).

Subjects	# of teachers who use CAL
1. Lang. arts	52
2. Mathematics	52
3. Computer studies	16
4. Social studies	15
5. Special ed./learning ass.	14
6. French	10
7. General science	9
8. Typing	8
9. Logic	2
10. Biology	2
11. Creative problem solving	1
12. N/A	1
13. (1 to 7)	1

Table 3.10. Subjects In Which CAL Is Used.

3.3.3. Student Access to Computers

The questionnaire results provide some basis to conclude that student access to the computer is at present far from adequate.

When asked the number of hours per week *the average student* spends in front of the terminal, 33 out of 59 respondents indicated 1 to 3 hours per week while 19 replied 0 to 1 hour (Question IV.2). A break down of the results are shown as follows:

# of hours per wk	# of teachers	Rounded % of teachers
0-1	19	32
1-3	33	56
4-6	4	7
7-9	0	0
10-12	1	2
13 or more	0	0
N/A	1	2
No answer	1	2
Total	59	

Table 3.11. Computer Access for Students.

Two factors must be borne in mind when interpreting these numbers. First, in answering this question, the teachers might be considering not the average individual student, but rather, an entire class of students. Hence, 1 to 3 hours per week of computer time are shared among 25 to 30 students. Teachers' tendency to respond on computer time for the whole class rather than individual student is documented in three cases when the respondents included the comments:

. 1 to 3 hours, during mathematics or language arts time, I will set up the computer with suitable disc and let the children work on it on a rotating

basis during the regular assignment work time;

. 25 - 30 students on 3 computers, 0 to 1 hour per week;

. 28 students share one computer, 6 hours per week.

Secondly, the computers may be available for only a few weeks and not throughout the whole year. Some respondents included comments as follows:

. 1 - 3 hours, not every week though, maybe 3 times per year;

. 1 - 3 hours, in 3 weeks block, 2 times per year;

. each student has 20 minutes every other day to work on selected mathematics and language arts programs, drills related to curriculum; 3 months use for 28 students;

. in 1983 to 1984, we rotated the two PET's and one COMMODORE 64 around the rooms 2 to 4 weeks at a time, lessening interest through the year in drill and practice.

Not all respondents took the time to explain their answers. While it is difficult to conclusively determine students' precise access to the computers, it would be safe to assume that in the most optimistic scenario, the average student can expect to work on the terminal for at most half an hour per week.

This conjecture is substantiated by results on another question (Question II.17). When asked how many hours per week they spend teaching with computer-aided instruction, most teachers replied 1 to 3 hours. Again assuming a class of 30 students, and an average of 5 computers in the classroom, in the optimal scenario, each student can expect to work on the computer for 30 minutes per week.

# of hours teacher spend teaching with computer	# of teachers	Rounded % of teachers
Less than half	6	10
Half – 1	8	13
1–3	21	35
4–6	8	13
7–9	2	3
10–12	10	17
13–15	0	0
More	3	5
Varies	1	2
N/A	1	2
Total	60	

Table 3.12. Teachers' Time on the Computer.

Another dimension to measuring access is whether students all enjoy equal access to the machines. In most schools, they do (Question IV.4).

Access	# of teachers	% of teachers
Equal access	48	77
Not equal access	14	23
Total	62	

Table 3.13. Equality of Access for Students.

From the comments teachers added on the questionnaire, it can be seen that they have developed a variety of strategies to give students greater access to the machines. On one end of the spectrum, some teachers try to give equal access to all students by rotation through a class checklist. Midway on the spectrum, some teachers give both equal and unequal access. One teacher commented that in introducing new concepts on the computer, equal access was rendered to all; but in remediation, the teacher determined which student needed more time. Similarly,

another wrote, "equal access to a point; then when everyone has had 2 to 3 turns that week and we have some remaining time, those that have finished their work go in groups". In a school which has a class of gifted students, the teacher interviewed indicated that equal access was allowed in the gifted class but not among the regular students. Another teacher employed a similar method: "with only five computers we expose as many students to the computer as is possible and then work with those who express interest".

On the other end of the spectrum, teachers give unequal access to the students. The main criteria for access are academic need and availability of suitable software. Students in need of extra help or remediation, and students qualified for enrichment often enjoy greater access. As one teacher said, "learning assistance and computer club students were given priority".

In addition to class time, computer instructional facilities are readily available to students in only 12 out of 64 schools (Question IV.7). Among these, 2 teachers replied that the computers are in the library the whole day: "before school, recess, all noon-hour, after school - all students have access to our library computers". In most cases, the computer is available with permission, which can mean student sign-up or teacher's permission.

Availability of CAL facilities	# of teachers	Rounded % of teachers
Readily available	12	19
Available with permission	40	63
Not available	11	17
N/A	1	1
Total	64	

Table 3.14. Availability of CAL Facilities.

3.3.4. Students and Computers

Teachers' perceptions on students' interaction with computers on a number of issues were collected. Over half of the teachers think that all students are suited to working with computer instruction (Question IV.6). The main difference among students of different ability levels lies in their interests in different kinds of software. One teacher in North Vancouver described it succinctly when she wrote,"LOGO appeals to creative, patient, high IQ students; average creativity, but "good" students like drill and practice; girls like word games, boys like more action to create own games".

Another remarked that all students liked Bank Street Writer but only high and medium abilities students preferred LOGO. On drill and practice programs, brighter students are observed to obtain higher scores but tend to become bored easier. Medium ability students are not bored as quickly while low ability students are bored easily and constant change of programs is necessary to maintain their attention.

Students best suited to working with CAL	# of teachers
All students	30
Students of high abilities	8
Students of medium abilities	9
Students of low abilities	8
Impatient students	2
Patient students	8
No answer	10

Table 3.15. Types of Students Suited to CAL.

Some teachers identified a core group of students whose interests in the computer remain constant over time. They are often "B students in general" but are high achievers in mathematics and computer studies. On the whole, student interest in computers was perceived to decrease after the initial excitement subsided, but the resultant level of interest remained substantial and relatively constant. One teacher explicitly traced a "response graph" as follows:
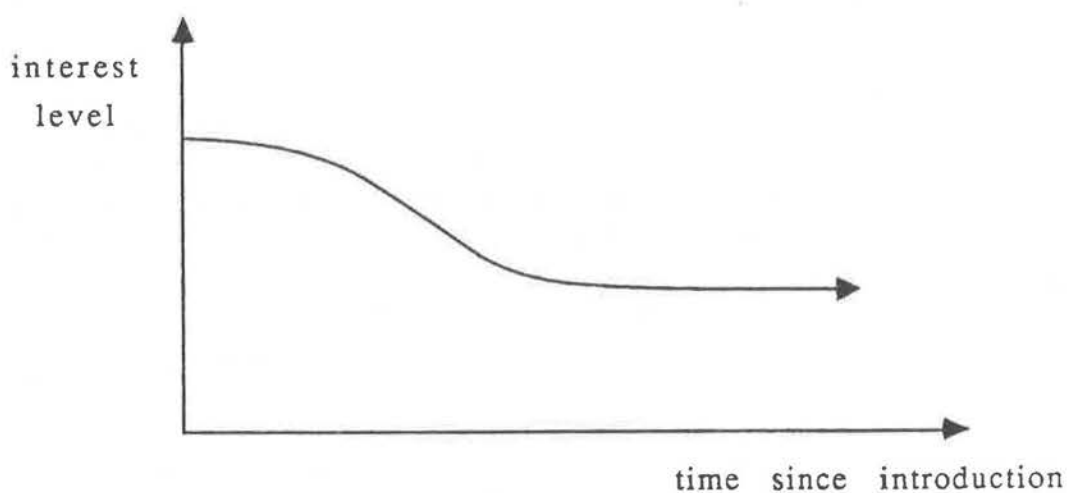
Figure 3.1.   Student Interest in Computers.

This description may well explain the results on questions on the impact of computer instruction over time (Questions IV.12, IV.13, IV.14).

	Yes	No	Don't know
Is the impact of CAL greater at the beginning when students find it a novelty?	37	11	12
Does interest wear off when they become more familiar with it?	16	25	14
Is their interest in CAL relatively constant over time?	37	9	15

Table 3.16. Novelty Effect of CAL.

Slightly over half of the teachers are highly receptive to students' responses to the software and take their opinions as basis for future selection of software. Some opinions are solicited informally through observation (Question IV.8).

	Yes	No	No answer
Are student responses to CAL solicited?	37	27	1
Are student opinions taken as basis for future selection of CAL software?	32	26	7

Table 3.17. Student Responses.

About 80% of the respondents believed that students should enjoy some degree of freedom in their learning (Question IV.17). 16% replied "don't know", and only

4% answered negatively to the query if "freedom helps learning". Given this predominant perception that freedom is beneficial to the learning process, it is not surprising that teachers allow students freedom in their interactions with computers in terms of the pace of learning, problem to solve, and topics covered. Three teachers reported that students could choose their own software only during non-class times. One teacher admitted freedom was allowed within the scope of activity predetermined by the teacher for that particular segment of computer time: "(it) varies with use and purpose of computer time; some instruction and challenge, some free-choice and discovery (are) planned for each period". Another teacher reported that students had no choice for they used the computer exclusively for word processing; freedom was limited to their choice in the topic of composition.

Freedom in	# of teachers
Pace of learning	43
Problem to solve	18
Topics covered	13
None	1
No answer or n/a	8

Table 3.18. Freedom in Student Interaction with Computers.

The majority of teachers perceived students' attention spans to have increased with use of the computer (Question IV.20).

Students' attention span	# of teachers	% of teachers
Increase	38	63
Same	3	5
Decrease	1	2
Don't know	18	30

Table 3.19. Attention Span of Students.

3.3.5. Difficulties Students Have With Computer Instruction

Incomprehensible instructions in the software constitute the most frequently encountered problem for students in the teachers' perception. Some also complained about the data being inappropriate for specific grade levels; and others about software being non-user-friendly (Question IV.15).

In response to the question on whether modifications are made to the software to deal with the difficulties, over 60% of the teachers replied negatively (Question IV.16).

	Yes	No	Don't know	N/A
Are modifications made to the software to deal with these difficulties?	12	33	8	1

Table 3.20.   Software Modifications.

One teacher who replied affirmatively pointed out that data were "customized for individual grades". Another wrote that "school board consultants have prepared simple programs for younger grades, to give a child more independence on the computer". The second biggest obstacle for students is problem with hardware. Breakdowns, difficulties with loading and finding programs are some more specific

stumbing blocks.

The third problem cited is inadequate quality supervision specially for the lower grade students. A qualified teacher who is present to help students with what seemed to be insolvable problems is deemed indispensable. Such a person would also be able to give individualized instruction and "allow each child to progress at his or her own rate". One teacher described a common phenomenon in the classroom when he (she) wrote:"when problems arise a teacher is often busy with a lesson; parent volunteers are invaluable in this respect".

Aside from reading and understanding instructions, students also have difficulties with typing, spelling the input correctly, and co-operating in a team. Inadequate time for students to complete programs or follow up on previous program are also mentioned in the list of difficulties encountered.

3.4 Conclusion

Survey results presented here provide a sketch of current computer use in the elementary classroom. The questionnaire also gathered information on teachers' perceptions on effectiveness of computer-aided learning. The next two chapters will juxtapose the interviewed teachers' quantitative as well as qualitative observations against relevant findings from the literature.

Chapter 4

Computer-Aided Learning :

Computer As Tutor

4.1 The Framework

This and the following chapter discuss various kinds of CAL software within the framework advanced by Robert P.Taylor (Taylor, 1980). Taylor suggests that all applications of computing in education fall under three modes : the computer functions as a *tutor, tool,* or *tutee*. Tayor then explains the three modes as follows:

> To function as a tutor in some subject, the computer must be programmed by "experts" in programming and in that subject. The student is then tutored by the computer executing the program(s). The computer presents some subject material, the student responds, the computer evaluates the response, and, from the results of the evalution, determines what to present next.

> To function as a tool, the classroom computer need only have some useful capability programmed into it such as statistical analysis, super calculation, or word processing. Students can then use it to help them in a variety of subjects.

> To use the computer as tutee is to tutor the computer; for that, the student or teacher doing the tutoring must learn to program, to talk to the computer in a language it understands. (Taylor, p.3 - 4, 1980).

According to this framework, the tutor mode is exemplified by software that assists in the presentation of new materials such as CAI, which includes drill-and-practice, tutorials, and simulations. When the computer serves as a facilitator to help one carry out a task, such as in executing a word processing or database program, the computer is a tool. Finally, it is used in the tutee mode when the student teaches the computer something, a good example of which is LOGO (Canale

et al., p.31, 1983).

This chapter presents a discussion of using the computer as a tutor while chapter five will complete Taylor's organization and investigates its use as a tool and as a tutee. Before embarking on a discussion of the different kinds of CAL software, we will first review the extent to which CAL software is adopted in elementary schools.

4.2 CAL in Elementary Schools

Drill-and-practice programs predominate as the major type of software adopted for classroom use. This observation is echoed in several studies conducted in recent years. According to a survey conducted by *Electronic Learning* (October 1982), a wide gap exists between school and everyday uses of the computer. When 2000 teachers and administrators were asked to list their favorite software, it is observed that,

> Of the 52 programs listed for use by students in mathematics, social studies, and English, four were simulations, three were designed to teach programming and two were aids for writing poems. The remaining 43 could best be described as drill-and-practice programs and games. In contrast, every program that respondents favored for their own professional use was a software utility or tool -- word processor, database management system, program editor, graphics editor, spreadsheet program, or file management.

Writing in April 1983, Kurland reaffirms the predominant use of CAI programs:

> the primary use of computers has been to replicate what teachers have been doing with other technologies (e.g. workbooks, dittos, flashcards)...For the most part, schools are using computers -- often begrudgingly -- as automated workbooks or, to a lesser extent, to teach introductory programming (Kurland, p.2, 1984).

An OISE survey of microcomputer software for language arts (Canale et al., p.8, 1983) again substantiates the widespread use of drill-and-practice programs.

While recognizing word processing as the best purpose the computer could serve in teaching language arts, teachers surveyed still cited drills as the most frequently used type of software. Word processing software is the next most frequently employed in English schools; however, "even in many English schools word processing is not yet in use" (Canale et al., p.8, 1983). Out of 100 questionnaires returned from 79 boards in Ontario, it is reported that drills are *often* used in 32% of the English schools and in 47% of the French schools; while they are *sometimes* used in 46% of the English schools and in 33% of the French schools. By contrast, software for composition is reported to be *often* used in only 27% of the English schools, and not at all in the French schools. The category of *sometime* usage is not reported for word processing software.

In a report published in February of 1984, Pea similarly notes that "as much as 95% of the microsoftware available today is *directive CAI* courseware, supporting already existing curricula in schools, such as percentages, and integer arithmetic in mathematics, vocabulary, and sentence composition and decomposition drills in language arts, and "fact" programs in the sciences or social studies. There is currently too much replication of everyday drill and practice, in which the computer becomes an expensive page turner, a flashcard robot, a fact-delivery system" (Pea, p.9, 1984).

Data collected from interviews with elementary teachers confirm the predominant use of drill and practice software in today's elementary schools. Over 70% of the teachers interviewed reported they adopted some drill programs in mathematics and/or spelling. Among these, most viewed drill-and-practice to be a

positive asset in helping students.

A more specific break down of CAI usages employed reveals that 57% of the teachers use tutorials and drills, and 51% use simulation programs (Questions III.20.a, III.22.a).

	yes	no	some times	don't know	n/a
Is simulation used?	51%	39%	3%	7%	-
Is tutorial with drills used?	57%	34%	-	7%	2%

Table 4.1. Modes of CAI Used.

In the Rand study of 1984, it is reported that over three-quarters of the 60 teachers surveyed used drill and practice software to varying extents. Two reasons are cited to explain this phenomenon. First, this type of courseware is most readily available. Kurland remarks that this situation is promoted by "many of the large educational publishers who want software that supports and looks very much like the textbooks they produced". Hence, when teachers turn to computer-oriented magazines for guidance in choosing software,"90% of the programs reviewed for the educational market are based on instructional drill-and-practice formats" (Kurland, p.5 - 6, 1983b).

The second reason for the widespread use of drill-and-practice programs is that whatever strategy of computer instruction is adopted, none systematically excludes this mode of instruction (Shavelson et al., p.50, 1984).

Data collected for this study confirm this finding. The picture that emerges from the interviews indicates that drill-and-practice software is felt to fit easily into the existing curriculum. And this is particularly true in the lower grades. Teachers interviewed reported that it was easier to isolate skills in the lower than in the higher grades. Consequently, matching software was more readily available for the lower grades. Students generally enjoy drill-and-practice in a game format. Some good mathematics programs like the Houghton Mifflin Series and the Milliken Math Series can provide some creative practice to students and they require little training on the part of the teachers to have them set up.

Of the 30% who did not use drill-and-practice software, some did not mention it at all and others were either skeptical of its use or against wasting a precious resource like the computer on an activity replaceable with drill cards. One teacher commented that she was "willing to try everything aside from drills"; and though she recognized scores improved with practice on the computer, she would do it only if every student had a computer at home.

Word processing closely follows drill-and-practice programs as the next most widely used piece of software. And LOGO is the third most widely adopted program.

Less than 10% of the teachers surveyed mentioned using the computer for database manipulation programs, music construction software, and simulation. The district of North Vancouver emerges as the most advanced of the four districts surveyed in that a number of their teachers, together with the district consultants, have already developed and taught a series of spreadsheet programs which emphasize

students' conceptual understanding of economic principles. And there is some experimentation on introducing elementary students to music composition on the computer. A few teachers interviewed alluded to simulation software as a more creative application of instructional technology. At the same time, however, they referred to the dearth of good simulation programs of which they were aware and the equally problematic lack of funds to acquire such programs.

About 15% of the teachers mentioned they did programming in either BASIC or LOGO with their students; but since programming does not belong to the domain of CAL, it will not be discussed.

After reviewing the existing situation in the schools, we will now discuss each type of CAL software separately. First, we will investigate the use of the computer as a tutor, i.e., computer-assisted instruction.

4.3 Computer As Tutor - CAI

4.3.1 Effectiveness of CAI

In this discussion, CAI means direct instruction of the students by the computer. This includes three kinds of software : drill-and-practice, tutorial, and simulation. In the following discussion of CAI, all three types are considered. Often a study may concentrate on a particular mode of CAI, but the overall result reported represents the cumulative observation applicable to all modes. As Edwards et al. (1975) have pointed out,

> based on available evidence, it cannot be concluded that any given CAI mode is more effective relative to student achievement than other modes (Edwards et al., p.35, 1975).

There are many studies which attempt to decide whether CAI is indeed effective. The conclusion gained from a reading of the literature is that CAI is definitely effective as a *supplement* to traditional teaching. Writing in 1975, Edwards et al. summarized research on the topic saying,

> all studies have shown normal instruction supplemented by CAI to be more effective than normal instruction alone (Edwards et al., p.147, 1975).

Writing in 1981, Burns and Bozeman reiterated this point with the words,

> published studies comparing the effectiveness of CAI to traditional instruction report conflicting and inconclusive results. The studies, however, generally conclude that an instructional program supplemented with CAI is at least as effective as, and frequently more effective than, a program utilizing only traditional instructional methods (Burns & Bozeman, p.35, 1981)

Later in the article, they stressed this effectiveness to be proven in at least one curriculum area - mathematics (Burns & Bozeman, p.37, 1981).

Hence CAI cannot be viewed as a mode of instruction separate from and in place of traditional teaching. In fact, studies that attempt to measure whether CAI *or* traditional teaching is more effective result in inconclusive results. Magidson (1978) has found that CAI is at least as effective as traditional instruction in 55 percent of the studies and more effective in 45 percent (Dence, p. 53, 1980). Another study also concludes that "those students who had both types of instruction achieved higher scores on the final exams than did those who received either CAI or the traditional instruction only" (Dence, p.53, 1980).

Most teachers surveyed in the present study did not know if use of CAI in fact improved achievement. When asked "is the level of achievement (score) higher with use of CAI", of the 62 teachers who replied, 65% answered "don't know", and 27%

replied "yes". Only 2% (1 teacher) answered "no" and another said "sometimes" (Question IV.9.c).

There is evidence to suggest, however, that CAI most often assumes a supplemental role. Given the predominant lack of hardware, this situation is understandable. In response to a question on "how much emphasis is placed on the CAI portion of a course, 37% of the teachers answered that it received 20% emphasis, 20% that it received no emphasis, 18% much emphasis, 11% said it received 50% emphasis, and 5% chose 0 to 10% emphasis (Question II.13).

Interviews with individual teachers confirm the positive correlation between supplemental computer drills and academic improvement. One teacher reported that learning assistance students improved in their arithmetic performance in the classroom after doing extensive drills on the blackboard, on paper, and on computer. He used Math Blaster for mathematics drills but reported difficulty in finding good drills for spelling and reading.

Another teacher also supported this positive correlation with no reservation. He reported that a student learned the multiplication table within two 40-minute periods on the computer.

A most enthusiastic response came from a grade 3 teacher in West Vancouver who used drills on the computer for 10 minutes per day for a period of 10 days. After the 10 days, she noted remarkable improvement in the students' scores. At the time of the interview, she was a novice on the computer and the addition drill was the only CAI she had used. A comparison of the two test results obtained before and after the computer drills revealed all students to have improved and the

average improvement to be 19.4%.

During the interview, she emphasized repeatedly the importance of organizing a disciplined environment in which CAI was to take place. She had two computers set at a corner of the classroom away from the main teaching area. Students were assigned a fixed schedule and two monitors were chosen to assist the two students working on the computer. Each student would leave the instructional area where she taught and go to work on the terminal when his/her predecessor on the terminal notified him/her of his/her turn. If s/he encountered difficulty, could ask for help from the two monitors. S/he was also expected to catch up on any instruction s/he missed by asking a "buddy". In this way, aside from the occasional key-typing noise, sound effects from the program, and low exchanges among the small group in front of the terminals, there was minimal disturbance to classroom activities.

Skepticism towards the effectiveness of CAI also exists among the interviewed teachers. Two teachers commented that CAI as a mode of instructional computer use had minimal importance because results of students who did drills were not impressive compared to those who did not. This skepticism is echoed in one study which suggests that perhaps the improvement in scores is due to "novelty effect" of the computer or some other factors associated with the experience of doing computer drills (Vinsonhaler & Bass, p.32, 1972). It poses the question, "how does CAI improve instruction?" To better understand this issue, we now turn to discuss those aspects of student performance which CAI indeed improves.

4.3.2 Students' Performance with CAI

4.3.2.1 Efficiency in Time

A reading of the relevant literature indicates that students need less time to learn a given amount of material with the use of CAI than without. This finding is unanimously supported in all the studies reviewed. Edwards et al's investigation summarizes the results of nine other studies and finds that "though CAI does not always result in greater achievement, the time it takes students to learn is reduced" (Edwards et al., p.149, 1975). Inquiries that echo this finding include the project done at OISE (Chambers & Sprecher, p.22, 1983) and others (Burns & Bozeman, p.36, 1981; Forman, 1983; Kulik, 1983; Magidson, 1978).

Some studies suggests substantial time saving with the use of CAI:

> Time saving of up to 40% were reported by Allen (1972) and Bunderson (Molnar, 1972). Bitzer and Alpert (1970) report that their medical science students using CAI took only one third to one half as much time to cover a semester's material as did students under traditional instruction (Dence, p.53, 1980).

About half of the teachers interviewed for the present study reported the same from their observations and experiences. When asked if "students picked up materials faster with computer aid", 48% replied affirmatively, 43% reported they did not know, 1% did not think the computer helped students learn faster and 4% said sometimes it did (Question IV.19.c). From the literature and survey results, it seems safe to conclude that efficiency in learning in terms of time spent is definitely improved with use of the computer.

Teachers were in general less familiar with the effects of simulation software. Hawkins reports from his research at the Center for Children and Technology at the Bank Street College of Education that "use of the computer as a simulation

instrument in the context of science/math is a relatively new concept to teachers" (Hawkins, p.6, 1982). The situation is true also in the four researched districts in Canada.

According to Edwards et al., like other modes of CAI, simulation reduces learning time (Edwards et al., p.149, 1975). Teachers interviewed for this study were in general unaware of this. When asked if learning through simulation reduced learning time, 55% replied they did not know, 25% answered affirmatively and 9% negatively; 6% chose a nebulous "sometimes" (Question III.20.d).

4.3.2.2 Attitudes

Student attitudes are reported to be positively correlated to computer usage in two studies (Forman, 1983; Chambers & Sprecher, p.22, 1983).

The comment that "kids love it but adults fear it" was repeated almost at every interview the researcher conducted with the elementary teachers. There is no doubt that students have an overwhelmingly positive attitude towards the "television they can control". Often teachers are psychologically intimidated by the blinking machine. With experience and hands-on practice, however, usually the fear is overcome (Brebner et al., p.377, 1980).

This is true for teachers as well as students. In response to the question, "do you think CAI is more effective in terms of helping the student to develop a more positive or negative attitude towards the computer", the answers are distinctly positive. Of the 65 teachers who replied, 80% chose "positive", 17% selected "don't know", and only 2% thought the effect was negative (Question IV.9.d). One district

consultant reported that conducting a session on introduction to the computer at a school "took out initial apprehension" for the staff. When the laboratory of computers left the school, there was momentum in the school to acquire some computers on their own.

4.3.2.3 Retention of Material

There are more studies which conclude poor retention of material learned with CAI than those which suggest a positive correlation of the two variables. Edwards et al.'s investigation surveys three studies, only one of which arrives at the conclusion that there is no difference in retention and the other two conclude traditional teaching method better helps retention. Edwards et al. have observed,

> even though students may learn more or may learn more quickly through CAI, there is some evidence that they may not retain as much as traditionally taught students (Edwards et al., p.151, 1975).

Forman echoes this finding (Forman,1983). Others, however, (Bitzer and Alpert, 1970; Kulik, 1983) indicate CAI students show greater retention than traditionally taught students.

The results from our survey reflect that the majority of teachers did not know whether retention was indeed enhanced with use of CAI. 55% of the teachers said they did not know when asked "do you think CAI is more effective in terms of helping students to retain learned material"(Question IV.9.a). 32% replied affirmatively and 3% negatively.

Edwards et al. have similarly suggested poorer retention of learned material through simulation. In the survey done for this study, teachers responded to a more

specific question on whether concepts taught through simulation are better retained, with mostly neutral responses. Of the 56 teachers who replied, 55% chose "don't know" as the answer, 34% selected "yes", and 5% chose "no". One teacher wrote "sometimes" (Question III.20.c).

Since the teachers did not indicate how they arrived at their choices, there is no basis to determine if their answers were guesses or actually experimentally-derived. In any case, it is safe to conclude that if the literature suggests retention of CAI material to be poor, most teachers were not aware of it.

4.3.2.4 Students Most Suited to CAI

The relevant literature suggests that CAI achieves the best results with low-ability students. Here, low-ability students do not mean those who are emotionally or socially maladjusted, but simply those who usually obtain low scores on tests. Edwards et al. have reported two inquiries which measure results of CAI according to the ability level of students:"both Martin (1973) and Suppes (1972) found CAI drill and practice in arithmetic to be relatively more effective for low ability students than for average or high ability students (Edwards et al., p.151, 1975).

Data collected from interviews conducted for the present study generally support this finding. Some schools which have only a few computers often place one in the learning assistance centre. Learning assistance students seem to prefer interacting with the computer because of the lack of negative feedback and infinite patience of the machine.

This coincides with the finding in one study which suggests that "immediate reinforcement available from a computer for each student response results in faster rote learning of correct responses than the limited, and usually delayed reinforcement available from a classroom teacher"(Braun, p.530, 1980).

One teacher reported that low-ability students were easily bored with one program and constant change of programs was necessary to maintain their interests. But a situation more often described involved learning-assistance students remaining glued to the terminal until their assigned time was over. Teachers at learning assistance centres were decidedly positive about the effectiveness of the computer. They reported students of low abilities enjoyed and needed drill and practice and that their achievement improved consequently. Often they were bored with traditional drill methods and computer drills revitalized their interests.

There is, however, a problem with transfer of knowledge or skill acquired at the learning assistance centres. Two teachers interviewed who worked exclusively with students requiring learning assistance reported that over 90% of their students made progress. However, their improvement was inadequate to enable them to rejoin the regular stream of learning in the classroom. One teacher, hearing this observation, discounted the phenomenon as applicable to students who were extremely far behind regular students; he believed with CAI, learning assistance students would catch up with their fellow classmates. Another remarked that if all that was required was straight copying of material learned on the computer to exercises or tests in the classroom, there was no problem. But if some conceptual application of the material learned was required, students might have difficulty. Further research is necessary to

fully understand the effect of CAI on learning-assistance students.

The response of teachers to the question, "do you find drill and practice to be effective in teaching students of low abilities", was generally positive. 73% of the 63 teachers who responded on the question replied "yes", 19% replied "don't know", 5% responded negatively and 2% said "sometimes" (Question III.19.a).

Patrick Suppes, a philosoghy and mathematics professor at Stanford, and a pioneer in the development of CAI, had contended that just like professional atheletes needed regular physical training to maintain their fitness, intelligent students needed drill and practice. He suggested that CAI was the best way to train gifted students (Suppes in Taylor, p.253, 1980). One teacher interviewed did comment that high-reading ability students were best suited to CAI drills. Another suggested computer drills could be used to stretch brighter students' abilities by setting fewer questions in each section so they would be forced to progress faster. Contrary to this view, some teachers felt that drill and practice was wasted on bright students.

All students could improve with drills, be they on paper or on computers. Low-ability students may be more suited to computer drills because of the immediate and positive feedback and patience of the computer. The question of who are most suited, however , is an issue that arises due to insufficient hardware. Basically, all children can benefit from the individualized instruction provided by drill programs, "with the brighter children receiving harder-than-average exercises, and the slower children receiving easier problems" (Suppes in Talyor, p.232, 1980).

4.3.2.5 Students' Attention Span

It has been reported in one study and the same point has been echoed by several teachers interviewed, that repetitive drills on the computer are not the best usage, and that the machine should be employed for more imaginative and creative uses (Sheingold et al., p.425, 1983). Used for drills, the computer is no more than an "automated workbook". There is a good deal of truth in the statement at the present time, when computers are still precious commodities in the schools. The argument that can be made in favor of using these "automated workbooks" is that they are more than "automated workbooks". While it has not been suggested in the relevant literature, there is ample evidence collected from the survey that students' attention span is greater when working with the computer than when working with say, drill cards. In fact, there is an undeniable excitement generated from working with the machines.

When asked if tutorial with drills is effective in holding students' attention, of the 57 teachers surveyed for this study, 61% replied "yes", 2% replied "no", and 26% replied "don't know". 4% said "sometimes" (Question III.22). Another question specifically asks whether attention span increases with CAI and again the result is extremely positive (Question IV.20). 38 out of 60 teachers thought that attention span increased with CAI, only 1 thought that it decreased, 3 replied the same, and 18 confessed they did not know.

Whether this "excitement" or increased attention to a new way of learning can be attributed to novelty effect is hard to tell. But if the response curve that the teacher described in section 3.3.4 is valid, even if the interest level does wear off after the initial stages, the students' attention span with the automated workbook is still

greater than that with the regular workbook.

4.3.2.6 Facts vs Concepts

If a clear distinction between facts and concepts can be assumed, then there is a general consensus among the teachers interviewed that the drill-and-practice and tutorial modes of CAI are better suited to teaching the former than the latter. Braun suggests that drills are effective when rote learning of correct responses is required (Braun, p.530, 1980). In the Rand study of 1984, among the 8 teachers who use exclusively drill-and-practice software, it is reported that they use it to achieve mastery of basic skills in mathematics and science and not for acquiring higher conceptual skills (Shavelson et al., p.41, 1984).

In the questionnaire distributed for this study, CAI is interpreted to mean drills and tutorials. When asked "is CAI best for teaching facts or concepts"(Question IV.10), 42% of the 57 respondents chose facts, and 21% concepts. 12% suggested both could be taught with CAI and 23% did not know what to reply.

In response to the question "do you find drill and practice to be effective in teaching mathematical applications", the response was a definite yes. Of the 65 respondents, 68% replied affirmatively, 14% negatively, 12% did not know, and 3% said "sometimes". This confirms the finding previously noted in 4.3.1 that CAI is proven effective in mathematices (Question III.19.c).

Over one third of the teachers surveyed had the perception that simulation is more effective in teaching concepts rather than facts, but the majority of the teachers were not certain. The response to the question "is simulation more effective

in teaching concepts rather than facts" included 39% "yes's", 36% "don't know's", 15% "no's", and 5% "sometimes"' (Question III.20.b).

One teacher interviewed said he would do more simulation with his students if he had more funds, for he considered it effective for concept teaching.

There is little in the literature to support this perception. Whether simulation indeed fosters concept learning is an issue that awaits research (Walker, p.106, 1983).

4.3.2.7 CAI As Motivator

The Rand study has reported that teachers do not stress the use of microcomputers for motivating students (Shavelson et al., p.ix, 1984). Research conducted for this study has repeatedly discovered teachers who called the computer "a motivator". Some teachers in fact used time on the machine as the carrot to keep discipline in the classroom or goad their students towards finishing some tasks.

Some teachers, however, offered a different viewpoint. One teacher commented CAI was effective only if the students were already motivated. Otherwise, personal interaction with a more senior student or the teacher provided more "stroking" and motivation to the reluctant student than the computer. For example, he suggested pairing a grade two with a grade seven student to learn the multiplication table.

Nevertheless, the fact remains that the infinitely positive feedback provided by the computer serves to motivate some students. Grimm (1978) reports that the effectiveness of CAI is largely due to its novelty and provision of prompt feedback. Similarly, Magidson finds informational feedback to be "an advantage of CAI"(Dence, p.51, 1980).

A more detailed investigation of feedback reveals that "feedback is effective because it is contingent upon student response" and it allows time for the student to first formulate his/her response before seeing the correct answer and the feedback (Dence, p.51, 1980). Another issue involves the effectiveness of delayed versus immediate feedback. Quoting Kulhavy's (1976) research, Dence reports that,

> Under conditions in which students cannot see the correct response before responding. immediate feedback is "one of the most powerful tools in the arsenal of instructional design"(Dence, p.53, 1980).

Another study, however, suggests that delayed feedback is more effective in helping students retain learned material (Dence, p.53, 1980).

Some teachers interviewed for the present study commented that at times the feedback overshadowed the purpose of the program. The feedback for an incorrect response was so graphically vivid that the students aimed not at getting the correct answer but simply to see the graphic display. In another instance, the positive feedback was to draw a part of a dragon. But unless a student could correctly complete all exercises in all sections, the entire dragon did not get drawn. This could be frustrating for a student who completed most of the exercises correctly but was never rewarded with the entire dragon.

4.3.2.8 Presence of a Teacher

It has been emphasized in section 4.3.1 that CAI is most effective as a *supplement* to traditional teaching. To make an implicit point explicit, it means that the teacher is the crucial factor that determines if CAI-supplemented instruction is to succeed. In fact, the critical role of the teacher cannot be over-emphasized

(Holmes. p.11-12. 1982; Brebner et al., p.378, 1980).

The teacher is critical in integrating CAI into the learning process, which means selecting the appropriate programs and guiding and encouraging students' efforts to explore the subject in more depth. He/she also organizes and manages the classroom so that CAI as well as traditional instruction can take place simultaneously. The teacher is important also in connecting in the students' minds skills that the computer delivers to skills applicable in the outside world (Judd, p.121, 1983). In assuming a supplemental role, CAI also frees the teacher from conducting the basic drills and hence more personal attention can be devoted to the students (Bitter, 1984; Chambers & Sprecher, p.84, 1983).

Most teachers interviewed for this study never used CAI as stand-alone material. One teacher who had extensive experience with CAI commented that it was "terrific" for students who used it in the presence of the teacher and other students, but was unsure it could be used as a stand-alone medium. Another suggested an awareness of the importance of the teacher's presence saying, "having CAI material is positive provided (the) teacher manipulates it well". Similarly, the teacher described in section 4.3.1 emphasized the disciplined organization of CAI in the classroom under her guidance as the main contributing factor for its success.

In response to the question whether teachers consider their assistance to be mandatory in CAI usage (Question III.13), two-third of the teachers surveyed for the present study replied affirmatively and a quarter negatively. 4% did not know and 3% suggested younger students could work on their own but older students might abuse the machines. And hence teachers should be present to supervise.

Stephen L.Chorover, a neuropsychologist and professor of psychology at the Massachusetts Institute of Technology, has cautioned that for the sake of improving productivity in education, stand-alone CAI may be introduced to replace the teachers. He describes a "goodbye teacher" syndrome as follows:

> After an initial investment in the hardware and software...the system will be extremely cost-effective. Instead of teachers who are subject area specialists, the school can hire relatively unskilled people to be "resource managers", and "system monitors", more commonly known as stockroom attendants and security guards. The university (or company) will provide all the expert assistance the school will need, including curricular material, lesson plans and examinations. The school will be able to say "goodbye teacher", and good riddance to that skyrocketing professsional payroll (Chorover, p.224, 1984).

Such a scenario could not have developed if the original intent of introducing computers into education, namely, to improve the quality of education, is considered. Ideally, teachers are not replaced but assume a new role of working individually with all students on any problems and questions they may have in assessing and handling the new concepts (Suppes in Taylor, p.234, 1980). CAI could potentially free teachers from the mundane aspects of teaching so that learning and teaching become *more* an individual affair rather than *less* so.

Chapter 5

Computer Aided Learning :

Computer As Tool and Tutee

5.1 Introduction

This chapter will discuss the other two functions Taylor suggests in his framework, namely, using the computer as tool and as tutee.

5.2 Computer As Tool

Several studies have pointed out that in the long run, the use of computers as tools would be the most important application of the technology in education (Matthews, 1984; Ragsdale, p.41-42, 1982; Kurland, 1983b). There is a wide variety of tool software, which can turn the computer into a drawing pad, word processor, calculator, music constructor, data organizer, graphing system, note taker, or bulletin board (Kurland, p.7, 1983b).

Research done for this study has revealed word processing programs to be the tool software most widely adopted in the elementary classroom. Graphics packages, spreadsheets, and messaging systems are also used to some extent. We will first discuss word processing.

5.2.1 Word Processing

An OISE survey on microcomputer software for language arts (1983) reports that 18 out of 79 boards in Ontario use word processing packages, "while waiting the development of software which is more suitable to the orientation of their language arts curricula than the many existing drill and practice programs" (Canale et al., p.13, 1983).

The results from the interviews done for this study indicate that Bank Street Writer is the word processing software most commonly used. 52% of the teachers surveyed adopted it, usually for the intermediate grades of 4 to 7. The other common software employed are Kidwriter for the lower grades and Dynatext for the intermediate levels (in North Vancouver). 10 of the 65 teachers used Kidwriter. Although the location is different, the increase in word processor usage compared to the figures from the 1983 survey may indicate a trend where more and more teachers become aware of the advantages of using the computer as a tool. However, many teachers interviewed have not tried word processing and composition classes are conducted in the traditional format. Limited access and unfamilarity with the software were some reasons cited for the lack of enthusiasm.

Word processing is seen as a valuable way to use the computer as a tool because it integrates naturally into the curriculum and is useful outside of schools as well. It takes slightly more familarity with the software than drill-and-practice programs on the teachers' part. But the effort is deemed worthwhile as many teachers reported improvement in both the quality and quatity of their students' writings. This will be discussed later.

One district consultant interviewed explained the importance of integrating computer usage into the curriculum. He pointed out that teachers were busy enough with their regular schedules. Unless something was deemed to facilitate the teaching process and concrete effects could be demonstrated, teachers would rather not adopt it. As tools, computers facilitated some assigned tasks which were part of the curriculum. As Canale et al. have observed,

> many curriculum innovations are never successfully implemented because teachers cannot easily integrate them with their set of personal beliefs and daily practices...However, the use of microcomputers for word processing provides an immediate and practical solution to this problem, assuming the availability of a printer (Canale et al., p.8, 1984).

Some schools in North Vancouver have successfully implemented this concept. Learning to write is a crucial area in any curriculum; using the computer as a word processor renders the process of writing more enjoyable and facilitates editing. The advantages of using the computer as a word processor are many.

First, the tasks of both writing and revision are considerably simplified with word processing (Hawkins, p.4, 1982). As Canale et al. have observed,

> It makes the mechanical aspects of the drafting and revision processes simpler to attend to. For example, legibility and neatness are virtually assured; a variety of modifications can easily be made without messy erasures; and new ideas can be quickly inserted and old ones moved around in the text. In principle, this allows more time and thought to be directed towards the higher level cognitive activities of planning, outlining, exploring, discussing, and qualifying one's ideas (Canale et al., p.9, 1984).

A second advantage of word processing associated to its ease of editing is that teachers become less hesitant to request corrections and students more open to suggestions for changes. As one teacher observed, writing, then, became like "clay to mold".

A major concern in using text processing is that students do not have sufficient typing skills. Canales et al. have suggested from their research that "not one teacher has found this to be a problem". From the interviews conducted for this study, it appears to be a minor problem.

In the interviews, little was heard about the disadvantages of word processing. Canale et al. have noted three disadvantages, which are insightful but which cannot be juxtaposed with teachers' views.

First, word processing programs may require quite a bit of attention to use, so much so that students spend more time trying to communicate with the machine than communicating their ideas through writing. In other words, the mechanics got in the way of writing. Second, existing word processing software may encourage attention to cosmetic aspects of writing like changing a word rather than facilitate moving whole paragraphs or making notes to oneself about possible changes. Third, software generally provides no means for the user to keep a record of the changes made or of other activities involved in the writing process. The product rather than the process receives the main emphasis (Canale et al., 1984).

What concrete effects then does word processing have on students' writings? Do their writings actually improve? If they do, then using computers as tools is a certain method whereby the quality of education is enhanced with the adoption of computers in the classroom.

5.2.1.1 Effectiveness of Word Processing

Kurland has observed the need for research on current software tools saying,

> research is needed to analyze the current software tools being used in schools; to evaluate the many other software tools which are currently available, irrespective of their intended audience; and to develop better means of integrating software tools into the classroom context (Kurland, p.12, 1983b).

This section will attempt to compare teachers' observations with the effects of word processing as suggested in the literature. It will evaluate word processing in terms of its effectiveness in improving the quantity and quality of writing. It will also present a method of integrating word processing into the writing class which has been observed to work reasonably well.

In the research done for this study, all the advantages mentioned by Canales et al. are cited in interviews by teachers to explain their choice of using the computer as a word processor. Many teachers attested to the finding reported in the literature that students wrote more and were more willing to write as a consequence of using some word processing programs. One teacher in North Vancouver commented that writing with a pen should go the way of the Roman numerals. She strongly recommended word processing for bright students who had poor motor coordination in writing with pen and paper.

Generally, teachers echoed the finding that students discussed their work more readily because the printed copy was more legible than their written copies. And co-operation was enhanced among the students as they helped each other to correct their mistakes. Seeing their work in neat, printed copies also served as additional incentive.

Spelling was observed to have improved because using the keyboard to type in a word made the student think more carefully about its spelling. Spelling was also

more easily corrected on the terminal, hence students were less hesitant to put down words. Once again, more thought could be spent on expressing ideas rather than on pondering the spelling.

There is little research done on whether spelling checkers actually improve or lower students' spelling abilities. Kurland has mentioned it, and has suggested implementing spelling checker programs which allow the teacher to decide the level of assistance given to the students (Kurland, p.10-11, 1983b). But the issue is beyond the scope of this study.

Kane's research has found that students spend more time composing with word processing and they feel more free to explore their ideas in writing because deletions and insertions are easier. They were more likely to use revision strategies learned and also because of the ease of revising their texts, students are motivated to learn new strategies for evaluating and revising their texts. However, the quality of their writing does not improve automatically with use of word processing. As Kane has observed,

> The word processor cannot teach students to be better writers; it only provides a means to effect changes more easily...Unless students have standards of good writing and can evaluate and revise their own work in terms of these standards, changes will not be improvements (Kane, p.23, 1983).

Several teachers interviewed echoed this observation that students wrote more, but the quality of their writing remained the same. One teacher commented students wrote more, and were more willing to correct, but their sentence structures and grammar were the same. Another pointed out though a neat copy might serve as incentive to the students, they also tended not to look as carefully for mistakes on the impressive-looking copy. A teacher with extensive experience in English

instruction observed that students' quality of writing remained the same whether by pen or on computer.

In accordance with Kurland's finding that students helped each other and discussed more with the availability of the typed copy, some teachers reported that students collaborated more when working on the computer. Social interaction increased when they saw the printed work, and because it was legible, they could read and discuss each other's work.

Quoting Donald Graves' work, Kane has stressed the crucial element in the learning process -- the teacher:

> Students develop as writers when their teachers value students' expressing their own ideas, discuss students' writing with them, and instruct them in the effective use of written language (Kane, p.23, 1983).

In the process of collecting data for this study, the researcher has found this to be the opinion of some very experienced educators. The principal of one elementary school commented that students were more concerned with the content of their writing because they knew they could easily change the format. But it was through the teacher pointing out their mistakes and discussing them, combined with the students' greater willingness to correct them, that writing improved.

Another teacher in North Vancouver attested that his students' spelling and sentence structure improved; he listed five reasons for the development. First, a lot of writing and discussion was concentrated in one month. Second, it was easier to make changes. Third, their written works became legible while before, they often could not comprehend their own writing. Fourth, they enjoyed it more. Fifth, students saw the result of their work when they saw it printed on the terminal. It is

significant that he placed the month of writing and *discussion* at the top of the list of reasons. Again, the guidance of a good teacher cannot be over-emphasized.

After understanding that it is the combined effect of a good teacher with use of word processing that improve writing, we will now investigate *how* exactly these two elements can work together.

5.2.1.2 The Process of Writing With Word Processing

Kurland has observed that "working with a word processor began to change *how* the writing process took place in the classroom on a number of levels, in addition to facilitating the mechanical aspects of producing a text" (Kurland, p.10, 1983b). Sheingold et al. have similarly remarked that the technology enabled the teacher to rethink her method of teaching. He/she can now demand more "review, feedback, and revisions by the students of their own and other students' work" (Sheingold et al., p.12, 1984).

We will now turn to an example of a successful integration of word processing into the writing curriculum. The information presented represents a conglomeration of observations from several interviews conducted in North Vancouver, which as a district has a commendable "Writing 44" program.

The setting involves a spare classroom which is divided into three sections. At least 10 computers with a printer occupy one section of the room, another section has tables and chairs where writing can be done, and the third section is an "author's corner" with carpet and cushions on the floor. The idea is to make this area comfortable and informal to create an easy atmosphere for discussion. This

room is the laboratory.

At the start of an English project to write an adventure story, for example, the teacher provides the students with ideas on the elements and composition of a good adventure story. This can be done in a brainstorming session on the blackboard in the regular classroom.

When the students have acquired some concepts on how to proceed in their task, they can start writing their rough drafts. Then the whole class is taken down to the laboratory. The class is divided into two groups, with the group ready to enter their writing on the terminals, working on the computer, another group still writing their rough drafts can continue to do so at the tables. The first group to use the computers can stay there for about 30 minutes, after which they give their places to the group at the tables.

The class is basically conducted in a rotation manner with each group working on the computer for about one hour per week. The amount of access to the machines is contingent upon the availability of the computers. If 30 computers are available at the laboratory then the class does not have to be rigidly divided into two groups and students can simply sit down at a terminal when they are ready.

The author's corner is for students who may want extra help on how to go about writing their adventure stories or who would like to have their ideas and writings critiqued by others.

When students have their rough drafts on hard copies, they hand them in at the editing centre. The editing centre consists of different stations; one or more students are in charge of one station, and assignment of students is again on a

rotation basis. Each station is responsible for correcting a certain syntactic error in the language. For example, one station corrects punctuation, another takes care of capitalization, etc.

Due to the divergence in abilities among the students, some students may not be sufficiently competent to spot, for example, all the punctuation errors. The teacher faces a dilemma whether to assign the competent students to certain stations or still insist on an equal opportunities situation and confront the consequence of certain errors being missed. In the latter case, it means the teacher has to do more work.

After a rough draft has been checked at all the stations, the student can then make the corrections on the terminal. When the student is ready, the teacher sits with him/her in front of the terminal and makes the final corrections together on the screen. The teacher can take the opportunity to explain to the student mistakes he/she has made, and because the piece has already been processed at the editing center, the teacher's burden of correction is substantially reduced. Finally, a finished adventure story is printed on hard copy.

During this process, the teacher can also observe the editing done by students. If students make many mistakes in one area, say, spelling, and the mistakes go unnoticed, he/she may want to take time to discuss that particular problem with the whole class.

A teacher at North Vancouver, from whom much of this information is obtained, has observed this process to effect remarkable progress in his students' writings. He commented that high achievers whose technical skills in writing were

already strong, wrote longer and more intricate stories, and included more characters in them. The ease of editing with word processing did not in itself improve writing, but freed the writer to devote his/her attention to the content, knowing technical errors can be easily remedied.

He also preferred the laboratory to the clasroom for writing. When the students came to the laboratory, they knew they would write. In a classroom situation, they might become more easily distracted by other activities. But the issue of laboratory versus classroom is a topic deserving of a chapter in itself and will not be discussed here.

5.2.2 Data Base Management System and Others

Although data base management systems have been extensively used in the commercial sector, they have not been widely introduced into the schools, and especially not into the elementary schools. As Freeman et al. have observed,

> it is apparent that the use of DBMS (data base management systems) as flexible information tools has not been thought about in depth by many teachers and school administrators. Schools are largely committed to computer programming and computer literacy, and are just beginning to consider tool software applications in the larger curriculum (Freeman et al, p.23, 1984).

Data base management systems are useful in helping students access and manipulate facts. For example, facts about different countries can be stored in a data base. And if students wish to compare say, marriage customs in several countries, the relevant facts will be presented. With facts readily accessible, students are encouraged to concentrate on arriving at some conceptual understanding on the issue. Data base management systems constitute an area rich in applications in the

curriculum and should be made available to younger students. From the interviews done for this study, only a few teachers used or contemplated using data base management systems.

Spreadsheet is another tool software which is being adopted. Spreadsheets can be used in any curriculum area which involves numbers. For example, in environmental studies, the teacher wishes to explore relationships of different parameters. By entering a new set of input numbers, the students can observe a different outcome. The spreadsheet software eliminates the tedious and maybe difficult arithmetic. And the students are challenged to interpret, explain and predict the relationships among the parameters.

This is adopted in some schools in North Vancouver with notable success. A spreadsheet program called "Dynabudget" was developed by a computer consultant of the district. According to this insightful educator, the purpose of the program was to teach students the process of thinking about economic systems. Through juggling figures in the spreadsheet, students were taught to think about relationships between numbers. The thinking process involved more than simple addition, substraction, multiplication, and division, which were mere algorithms. For example, a question indicated that a certain sum of money was available, and three items were bought, approximately how much did each item cost. The students would enter the amounts for each item and try different combinations. This, he stressed, was what people in real life situations had to do. The program proved to be captivating to students.

Another tool software used in a few schools in North Vancouver is a messaging system. Ragsdale's observation that this could be a first step in introducing beginners to the technology proves implementable (Ragsdale, p.100, 1982). Students enjoyed sending messages to each other and the "convenient and uncomplicated service(s)" was extensively used.

While effective as an initializing tool, the messaging system may serve little purpose beyond that. Students were reported to treat it as too much of a toy. Often nonsensical messages were written and sent without further proof reading; and discipline problems arose as students decided to continue their messaging verbally.

5.3 Computer As Tutee

In tutee mode CAL, the computer provides an environment which facilitates learning, but the student is in full control of how he learns. David Moursund explains this mode saying,

> the student acts upon a computer; the student is in charge, directing the interaction and learning by doing. The computer helps to provide a rich learning environment, but the computer is not pre-programmed with information to be taught to a student. Tutee mode CAL generally requires that a student learn quite a bit about a computer system and its language (Moursund, p.86, 1981).

The key idea is using the computer system to create a rich and interesting learning environment. The student can then explore and learn in this environment. Theoretically, tutee mode CAL can provide environments such as art, music, the physical sciences etc. The tutee mode CAL most widely adopted today is Seymour Papert's LOGO. Much research has been done on LOGO, this section does not attempt to add new insights to the many already offered in other inquiries. Rather,

we aim to discuss the views of the teachers interviewed in the four districts against a backdrop of findings from the literature.

5.3.1 Current Usage of LOGO in Elementary Schools

Next to drill and practice programs, LOGO is the next most widely used piece of software. 84% of the teachers interviewed for this study adopted it for classroom use. It appeals to students across all grade levels, with the younger students using the simplified version, E-Z LOGO. Even kindergarten students were observed to learn the concepts of left, right, forward, and backward very fast with LOGO.

In most schools, only the LOGO turtle is introduced to teach geometric concepts. The more difficult functions of list-processing are often ignored. But teachers' responses on using LOGO to teach logic and spatial relationships are positive in general.

From the interviews, it is safe to assume that over 90% of the teachers are aware of the existence of LOGO. The levels of competence among them and the difference in availability of machines at the schools, however, render the extent of its use to vary greatly. To overcome this problem, the district board may have a travelling laboratory of computers and a LOGO expert who visits the schools in the district, doing inservice for the teachers and teaching the students. The students' response to these laboratories are overwhelmingly positive, but the demands on the travelling local LOGO expert are correspondingly high.

Teachers' acceptance of LOGO also varies. Some recognized it to be a "catalyst" in introducing students to computers and that "kids loved it". Some

valued LOGO as a "sequence-builder" and that it taught process-oriented thinking. Some saw it as a good supplement or extension of geometry-instruction. Others were not impressed by it, calling LOGO a "solution for a problem not yet defined". While they did not object to using it, they thought it had been overly promoted. In view of the conflicting opinions, we will now turn to a consideration of the pros and cons of using LOGO.

5.3.2 LOGO

Papert created LOGO as a vehicle for introducing students to computers. One of his fundamental ideals is that learning to communicate with computers can be a natural process analogous to learning the language of a country in which one lives. Similarly, through interaction in an environment of mathematics, students learn mathematical concepts in a process of self-discovery. And LOGO is the means whereby this discovery is made possible. As Ragsdale has observed,

> When Papert was young, he used gears as models for abstract concepts and found that they facilitated his understanding. LOGO is his "gear system" for young children so they can construct models of the abstract concepts of mathematics (Ragsdale, p.39, 1982).

It is a highly idealistic goal that Papert attempted to achieve in education. He felt that students generally lacked encounters with ideas and materials that stimulated higher cognitive skills. But computer-based education can create a new educational culture in which there are no limits to the amount of discovery and learning that students can undertake (Molnar & Deringer, p.117, 1984). Papert wanted to provide an environment so students were free to explore mathematics on their own terms, to secure their "ownership" of math ideas (Thornburg, p.24, 1984).

The only prerequisite to such exploration is learning the language, LOGO.

There is little doubt that LOGO is highly successful as the means to introduce students to computers. One teacher who viewed computers as a natural part of education called LOGO "the main catalyst" to introducing the technology. Its graphics and simple commands render it highly popular among students.

But is LOGO equally successful as the vehicle to enable students create models for abstract mathematical concepts? In fact, one teacher commented that students were attracted to the "fancy graphics" and game-like aspects of LOGO but were uninterested in the drudgery of procedural thinking and programming. We will now investigate the extent to which LOGO is effective in accomplishing its instructional objectives.

5.3.2.1 Effectiveness of LOGO

In their discussion of LOGO, Shavelson et al. have suggested that LOGO reflects considerations of four educational objectives. First, they claim that LOGO teaches programming. It is, as they observe, an "ideal introduction to programming and to sound problem-solving methods" (Shavelson et al., p.228, 1984). LOGO being a structured programming language, it encourages planning of the solution first rather than starting right in with the solution like BASIC. The reasoning process involved to specify and encode the solution to a problem in the context of programming can have positive effects on the person's general problem solving abilities (Shavelson et al., p.226, 1984).

This emphasis on problem-solving deserves some clarification. Problem-solving, defined in a broad sense, is felt by many educators to be a central theme in education. It is defined as the process of applying previously acquired knowledge in new and unfamiliar situations. Previously acquired knowledge may include knowledge of one's own or that of others.

There are generally two kinds of problems. First, a problem whose solution is evident or immediate to a person; this type of problem is called a primitive. Second, problems which are not readily solvable. Hence the process of problem solving involves a process of stepwise refinement in which the second type of problems are broken down into primitives. Through programming in LOGO to draw pictures, students undertake this process of planning or stepwise refinement as well as gain experience in other problem-solving tasks like estimation, experimentation, and pattern recognition. Hence, a second instructional objective of LOGO is to foster problem-solving and planning abilities in students.

A third objective is to foster a more spontaneous and creative attitude to learning. In the LOGO microworld, students are encouraged to explore and try out different solutions. If a program fails to accomplish its task, it is modified repeatedly until it works. In traditional schooling, "errors" meant "failure" and are to be avoided at all cost; but in the LOGO microworld, "bugs" are to be corrected and are not interpreted as "failure". As Shavelson et al. have observed, "creative learning of the sort claimed for LOGO suggests that bugs are a natural part of the learning experience" (Shavelson et al. p.227, 1984).

A fourth and most obvious objective is that LOGO teaches concepts of mathematics and geometry. We will now discuss the extent to which these objectives are indeed accomplished.

[1]   Does LOGO teach students programming?

LOGO has been commended by one teacher as the "best form of computer programming". Many teachers have echoed the Rand study's recommendation and have preferred LOGO to BASIC for LOGO is a structured programming language. Shavelson et al. have pointed out that with LOGO, elementary students can acquire most of the basic concepts of a structured programming language, and can proceed from there to learn PASCAL. BASIC is deemed not worth learning. This preferrence for LOGO and PASCAL over BASIC as the main programming language taught has been suggested by many teachers.

While LOGO consists of the elements of a structured programming language, to proceed from turtle geometry to applying and appreciating the intricacies and elegance of the other features of LOGO involves a gigantic leap. It is doubtful that such a leap can be made given the dearth of machines and trained personnel at today's elementary schools.

Papert hoped that students would become acquainted with the features of a structured programming language through self-directed interactions with LOGO. This hope has been proven to be unattainable according to two studies done at the Bank Street College of Education in New York. Kurland and Pea have concluded that in learning programming, many sources of confusion have been found to emerge with the absence of instruction:

contrary to Papert's idealistic individual "Piagetian learning"...self-guided discovery needs to be mediated within an instructional context (Kurland & Pea, p.9, 1983).

Similarly in another study, Pea has observed that LOGO is cognitively complex beyond its early steps and "quite difficult to learn without instructional guidance, even if students are intellectually engaged with that learning" (Kurland & Pea, p.2, 1983). The guidance of a trained teacher is deemed indispensable if students are to learn programming and thinking skills,

> the pedagogical fantasy...that LOGO can serve as a stand-alone center in classrooms for learning programminng and thinking skills does not work. Teachers' training will be necessary for programming skills to develop very far, and problem-solving skills may need to be taught directly rather than assumed to emerge spontaneouly from learning LOGO (Pea, p.2, 1983).

Hence, LOGO is effective as the medium to teach programming only with appropriate teacher guidance.

[2]   Does LOGO indeed foster problem-solving skills?

One teacher has commended LOGO for it teaches sequential, logial thinking. A good deal of reasoning is involved in programming to create an image on screen. But whether this sequential, logical thinking is transferrable to other domains and improves a person's general problem solving abilities is hard to demonstrate. One teacher in fact has expressed his doubt that LOGO is good for teaching problem-solving.

Papert believed that the students' self-discovery of the logical steps to a solution by a process of intuitive trial and error would foster his general problem-solving abilities. But studies done at the Bank Street College of Education found that this is not true.

Mawby et al. have concluded that it is unclear how students could practice the powerful problem-solving strategies embodied in LOGO saying,

> If children had a thorough understanding of LOGO, they might exploit LOGO's modular structure as a support in problem solving. Reciprocally, if children generally employed explicit high-level strategies such as problem decomposition, they might discover in LOGO a powerful problem-solving environment...But the children we studied had neither deep knowledge of LOGO nor explicit problem-solving strategies. Since interesting screen effects can be generated from simple LOGO programs, free exploration of the computer does not tend to move children to explore the powerful problem solving ideas embodied in LOGO (Mawby et al., p.37, 1984).

Despite the fact that their studies were conducted in a computer-rich environment of four students to a computer, Pea and Kurland have found no transfer of cognitive abilities learned in programming to planning. They have concluded that students can not learn planning and problem decomposition without guidance; learning through self-discovery is simply inadequate. As Pea and Kurland have observed,

> Learning how to plan well is not intrinsically guaranteed by the LOGO programming environment: it must be supported by teachers who, tacitly or explicitly, know how to foster the development of planning skills through a judicious use of examples, student projects, and direct instructions... (In Papert's model), teachers are told not to teach, but are not told what to substitute for teaching (Pea & Kurland, p.44, 1984)

They have suggested that it might be more fruitful to teach the heuristics of problem-solving than to expect students to learn them in a LOGO-environment. Hence, teacher instruction is indispensable if LOGO is to be effective in teaching planning and problem-solving skills.

[3]   Does LOGO foster a creative attitude to learning?

Studies conducted at the Bank Street College have noted students' "mental engagement" with turtle graphics. Many teachers also reported the highly positive

response students demonstrated to working with LOGO. One district consultant who travelled to different schools to teach LOGO also commented that he noticed a big gap between Papert's goal for LOGO and what he was accomplishing at the travelling laboratory:"I don't know why I am doing it except everybody likes it and the kids go out smiling". Whether an attitudinal effect has been produced is difficult to measure, but it is safe to assume from the smiles that LOGO promotes a positive attitude towards learning.

[4] Does LOGO teach geometric and mathematical concepts?

This objective is most clearly achieved. It is often the precise reason teachers use LOGO. While LOGO is used as an interactive word processor in some schools in the district of North Vancouver, most teachers only adopt the turtle graphics aspect of LOGO. We will confine our discussion to turtle graphics.

On the entry level of learning, students are introduced to cause-and-effect, cursor control, and spatial relationships. Identifying their own body-image with the turtle, or anthropomorphizing, is a highly valued attribute of LOGO. Off-computer activities to introduce the LOGO commands of left, right, forward, and backward prove highly successful in introducing even kindergarten students to the computer microworld of LOGO. One teacher described to the researcher the excitement generated when a student was dressed up as a robot. With the floor drawn as a grid and a destination set at one square in the grid, the robot was instructed by the class on the steps to move to the destination using the four commands of forward, backward, left and right. If a number was not specified after the command, the robot might crash into the wall. In this way, students were taught the rudiments of

a procedure and the need for parameters.

After acquiring these concepts of spatial relationships with their own bodies, the same ideas were reinforced using a programmable truck and finally with instant LOGO on the terminal. The teacher reported that even kindergarten students grasped the concepts with no difficulty. These concepts were then tested when students attempted to implement higher level concepts like symmetry or reflection through constructing different geometric figures.

Teachers in general recommended using LOGO for "exploratory mathematics". They valued it for it was process-oriented and allowed students to utilize their own intuition and abilities in devising a solution. However, it is doubtful that students could actually learn geometry through LOGO. One teacher commented that students did not learn that a circle was 360 degrees through LOGO. Another pointed out that these concepts had to be taught first, and then LOGO allowed students to explore them.

Hence, although LOGO is inadequate in teaching geometry per se, it can doubtlessly provide a "geometry land" where students can implement and test simple mathematical concepts such as estimation, symmetry, reflection, perceptions of left and right, etc.

After reviewing the different kinds of CAL software used in the classroom, we will next summarize some of the points discussed in these two chapters and suggest an approach whereby teachers can improve their instruction using the software.

Chapter 6

Summary, Recommendations and Conclusions

6.1 Summary

A central theme that emerges from this study on CAL is that the teacher is the deciding factor in whether introduction of CAL into the classroom will be a success. The computer can help students to learn faster, maintain longer attention spans, and become more interested in learning, but the *quality* of what students learn ultimately rests with the teacher.

Studies have been conducted to show that using the compter as tutor, i.e. CAI, is effective as a supplement to traditional teaching. This study further suggests that in the other two modes of tool and tutee, the computer functions to its best potential also as a supplement to traditional teaching.

In word processing for example, students' writing improves only with the guidance of a good teacher. Similarly, data base management software and spreadsheets are no more than tools to help students acquire the concepts the programs illustrate.

Without teachers' assistance, students may acquire some experience with drawing geometric shapes using LOGO. But with guidance, they learn to associate the shapes with their underlying concepts. Studies have further documented the necessity of teacher guidance in learning programming and problem-solving skills with LOGO.

6.2 Recommendations

The need to integrate computers into the curriculum has been widely recognized as one of the most important issues in educational technology (Flodin, 1984; Wilton, 1984). Many teachers interviewed similarly noted this need. But integration does not mean simply incorporating computer use into the existing curriculum. The goal is quality education. If computer instruction embodies more desirable educational objectives, then the curriculum can be adjusted to better integrate this technology.

At the present stage of development, however, research has mainly focused on how the technology can "fit into" the curriculum and not vice versa. The aim at present is to better utilize the computer as a means to instruction. As Flodin has observed, the vital issue in educational technology at present is "the need to integrate computers into the classroom as means rather than as end" (Flodin, p.34, 1984). One district consultant succinctly put it saying, "the computer should become as invisible as the pencil in the classroom". So how should teachers attempt to use the computer as they would a pencil?

Just like we would use a pencil only if it is necessary and indeed superior to whatever we used before pencils were available, the computer is employed only in those areas where it indeed proves superior to the traditional method of instruction. Which then, are those areas?

This study has discussed CAL software within the framework of using the computer as tutor, tool, and tutee. In view of the two prerequisites to integrating computers into the classroom, namely, availability of machines and teachers' competence, priorities can be assigned to the three usages. Indeed, many teachers

have commented that inadequate machines introduce problems rather than enhance instruction. Hence, given sufficient machines and trained teachers, which are the areas in the curriculum where CAL can be used?

Employing the computer as tool is one area which many studies have indicated to be educationally beneficial and cost-effective (Ragsdale, 1982; Hawkins, 1982; Kurland, 1983; Canale et al., 1984; Wilton, 1984). Tool software, and especially word processing programs, are already being used in schools.

Word processing can stretch across all subject areas and has been noticed to improve students' writing. It takes slightly more familarity with the software on the teachers' part than drill programs. But given the limited access students have on the machines in today's elementary schools, and the wide applicability of writing and word processing skills outside of schools, using the computer for writing is the most fruitful way of integrating the computer into the curriculum.

In the more advanced districts, data management and spreadsheet software are also adopted. Integrating all three tool software so that the students have all three processes simultaneously at their command may be the next step.

While Papert's goal of creating an environment of self-discovery learning is overly idealistic, and the precise benefits that may be derived from LOGO still open to research, there is little doubt that LOGO does provide a creative and definitely positive educational experience for students. Teachers have to spend more time familiarizing themselves with LOGO than with word processing. Given the current availability of computers and competence levels of teachers, LOGO is accorded second priority to word processing.

Drills for mathematics and language arts and less frequently, simulations for the social sciences and sciences, are found to enhance instruction if used as a *supplement* to traditional teaching. Arguments can be made that other less expensive supplements may serve the same purpose and judicious choice of software is important because good CAI programs are few. Since hardware is generally inadequate and teachers lack time to select the good programs, CAI is unlikely to play a significant role in classroom instruction.

Insufficient machines and lack of trained personnel are crucial obstacles to the expansion of computer instruction in the schools. Both factors need to be addressed if CAL is to live to its full potential within the school system.

6.3 Conclusions

This study has analyzed the use of CAL software in the elementary classroom in four chosen districts. It has attempted to provide information on student access to computers in elementary schools and evaluated different kinds of CAL software currently used. Finally, it suggests an integrated approach to adopting CAL into the curriulum.

Further work needs to be done to investigate student use of computers, design criteria of good educational software in different curriculum areas, and the strategies of integrating software into instruction in each case.

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Appendix

Questionnaire

I. Background on teacher

1. How many years have you been teaching?

     __ 1 - 3   __ 7 - 9   __ 13 - 15

     __ 4 - 6   __ 10 - 12   __ 16 or more

2. What was your major in college?

     __ arts   __ science

3. What subjects do you teach at school?

     __ social studies   __ science   __ learning assistance

     __ language arts   __ math   __ other:

4. Which grades do you teach?

     __ I - IV   __ VIII - X

     __ V - VII   __ XI - XII

II. Educational Computer Use and Teacher

1. When was CAI first introduced in your school?

     __ 1961 - 1965   __ 1966 - 1970   __ 1971 - 1975

     __ 1976 - 1980   __ 1981 - 1984   __ before 1961

2. What machines do you use now? How many are there in the school?

machines:__ Commodore 64; how many? ____

          __ Apple II ____

___ Apple compatible ____

___ PET

___ other, please specify:

3. What software packages do you use? In which grades are they used?

grades: grades:

___ LOGO   ___ Stickybear number

___ Bankstreet Writer   ___ Stickybear ABC

___ Milicon Math Series   ___ Speed Reader II

___ Milicon Reading Series   ___ PEMC W.E. 7

___ Milicon Language Arts Series   ___ PEMC W.E. 10

___ Kid Writer   ___ Rhymes & Riddles

___ Mastertype   ___ Math Blaster

___ Fay that math woman   ___ Wizard of Words

___ Math Worksheet   ___ Koala Pad

___ Math Activities Courseware   ___ Mob Town

___ Houghpon Mifflin Series   ___ MAC 4

___ MECC Language Arts Disks   ___ MAC 5

___ Factory   ___ MAC 6

___ Rocky's Boots

4. Are teachers trained in the use of CAI? Or do they learn on their own?

___ trained   ___ self-trained   ___ both

5. Do you develop any of your own software?

___ yes   ___ no

6. Is the documentation of the software adequate?

  __ yes   __ no   __ don't know

7. Are there any remote connections of computer systems to those elsewhere?

  __ yes   __ no   __ don't know

8. How are the teachers' objectives defined in CAI? What are their relative priorities?

  priority:

 goals: __ individualized instruction,

     __ mastery of learning,

     __ improving teaching effectiveness,

     __ computer literacy,

     __ word processing,

     __ work on computer as a reward,

     __ just to occupy the students,

9. What selection critieria are used for choosing the machines and software?

please comment :

10. In which subjects is CAI used?

 __ language arts   __ general science   __ computer

 __ math   __ social studies   __ french

 __ special ed / learning assistance

11. Do you think CAI is effective in teaching a foreign language
?

         __ yes   __ no   __ don't know

12. Is the CAI software used as stand-alone instructional
material, or is it integrated into the lessons?

        __ stand-alone   __ integrated

13. How much emphasis is placed on the CAI portion of a course?

        __ much emphasis   __ 50% emphasis
        __ 20% emphasis   __ no emphasis

14. Which packages do the students like most?

__ LOGO	__ Stickybear Numbers
__ Bankstreet Writer	__ Stickybear ABC
__ Milicon Math Series	__ Speed Reader II
__ Milicon Reading Series	__ PEMC W.E. 7
__ Milicon Language Arts Series	__ PEMC W.E. 10
__ Kid Writer	__ Rhymes & Riddles
__ Mastertype	__ Math Blasters
__ Fay that math woman	__ Wizard of Words
__ Math Worksheet	__ Honeybear
__ Math Activities Courseware	__ Dynaword
__ Houghpon Mifflin Series	__ MAC 4
__ MECC Language Arts Disk	__ MAC 5
__ Rocky's Boots	__ MAC 6
__ Factory	__ Mob Town

15. Is there any inter-school or inter-school board communication on the selection of CAI software?

      __ yes   __ no   __ some

16. Are audio-visual aids used in conjunction with CAI software?

      __ yes   __ no   __ sometimes

17. How many hours per week does the teacher spend teaching with CAI?

      hours:__ less than half an hour

              __ half an hour to 1

              __ 1 to 3   __ 4 to 6   __ 7 to 9

              __ 10 to 12   __ 13 to 15   __ more

18. What is the total number of teaching hours?

      total hours: ____

19. a. Do you find drill and practice to be effective in teaching students of low abilities?

      __ yes   __ no   __ don't know

    b. Do boys like drills better than girls?

      __ yes   __ no   __ don't know

    c. Do you find it effective in teaching mathematical applications?

      __ yes   __ no   __ don't know

20. Simulation is to recreate a situation with a program.

    a. Is this used?

__ yes   __ no

b. Is it more effective in teaching concepts rather than facts?

__ yes   __ no   __ don't know

c. Are concepts taught this way better retained?

__ yes   __ no   __ don't know

d. Does learning through simulation reduce learning time?

__ yes   __ no   __ don't know

21. Is CAI effective in teaching mathematical problem-solving?

__ yes   __ no   __ don't know

And traditional methods effective in teaching computation and concepts?

__ yes   __ no   __ don't know

22. Is mixed mode CAI, tutorial with drills, used?

__ yes   __ no

Is it effective in holding students' attention?

__ yes   __ no   __ don't know

Is it effective in helping students achieve higher scores?

__ yes   __ no   __ don't know

III. CAI and Students

1. How often is CAI used in each class? How is it introduced into the classroom? (e.g. do you put examples on board first, then let the students work on their own, or what procedure of teaching do you use?)

__ once a week   __ twice a week   __ 3 times/week

__ 4 times /week   __ 5 times/week   __ more

please describe procedure of teaching:

2. How many hours per week does the average student spend in front of the terminal (including both in-class and out-of-class hours)?

    __ 0 to 1   __ 1 to 3   __ 4 to 6

    __ 7 to 9   __ 10 to 12   __ 13 to 15

    __ 16 to 18   __ more

3. Do the students co-operate in pairs, in groups, or do they work alone?

    __ in pairs   __ in groups   __ alone

4. Do all students have equal access to the terminal and software, or are they chosen according to some criteria?

    __ equal access   __ not equal access

    __ chosen, please specify how:

5. If students are chosen, or choose, to work with CAI, how are they tested as compared to students not exposed to CAI?

    __ not tested/don't know

    __ tested, comment on how:

6. Any observations on which students are best suited to working with CAI?

       __ students of high abilities   __ impatient students

       __ students of medium abilities   __ patient students

       __ students of low abilities   __ all students

       __ others :

7. What is the availability of CAI facilities to students in addition to class time?

    __ readily available   __ available with permission

    __ not available

8. Are student responses to CAI solicited?

       __ yes   __ no

And their opinions taken as basis for future selection of CAI software?

       __ yes   __ no

9. Do you think CAI is more effective in terms of helping the student to:

    a. retain learned material?

       __ yes   __ no   __ don't know

    b. maintain student interest - do students drop out or stay in the course with CAI?

       __ drop out __ stay   __ don't know

    c. improve efficiency - do students pick up materials faster

with computer aid?

      __ yes   __ no   __ don't know

   d. develop a more positive or negative attitude towards the computer?

      __ positive __ negative   __ don't know

   e. is the level of achievement (score) higher with use of CAI?

      __ yes   __ no   __ don't know

10. Is CAI best used for teaching facts or concepts?

      __ facts   __ concepts

11. Do you see assistance of the teachers as mandatory in any CAI usage?

      __ yes   __ no   __ don't know

12. Is the impact of CAI greater at the beginning when the students find it a novelty?

      __ yes   __ no   __ don't know

13. Does interest wear off when they become more familiar with it?

      __ yes   __ no   __ don't know

14. Or is their interest in CAI relatively constant over time?

      __ yes   __ no   __ don't know

15. What are some difficulties students have with CAI ?

Difficulties:

16. Are modifications made to the software to deal with these difficulties?

        __ yes   __ no

  if yes, please specify:

17. How much freedom do students enjoy in their interaction with CAI?

Freedom in :

  __ pace of learning   __ topics covered   __ problem to solve

  __ none   __ others, please specify:

Freedom helps learning?

        __ yes   __ no

18. Do you think CAI is particularly helpful to students with learning disabilities?

        __ yes   __ no   __ don't know

19. Do you think CAI is beneficial and helpful to emotionally maladjusted students?

        __ yes   __ no   __ don't know

20. Does the attention span of students increase or decrease with CAI?

      __ increase   __ decrease   __ don't know

IV. Observations

1. Any observations on how standard teaching methods compare to CAI? Please comment :

2. Is CAI welcomed by teachers, students, parents, and school authorities?

      welcomed by teachers: __ yes   __ no

                students: __ yes   __ no

                parents: __ yes   __ no

          school authorities: __ yes   __ no

3. Have control groups ever been set up to gauge the effectiveness of CAI?

      __ yes   __ no

result:

4. Do boys show more interest in CAI than girls?

__ yes   __ no   __ don't know

a. What about their levels of achievement?

__ boys higher   __ girls higher   __ don't know

b. Which group is more likely to show up to play with the terminals after class?

__ boys   __ girls   __ both

V. Future of CAI

1. What machines are more desirable for implementation of CAI?

a. __ minicomputer   __ microcomputer

b. __ stand-alone computers   __ computer in network

c. __ audio-visual additions   __ don't know

2. Is there any need for greater co-operation among different schools or school boards?

__ yes   __ no   __ don't know

3. Is greater government funding necessary?

__ yes   __ no   __ don't know

Are machines and software cheap enough for schools?

__ yes   __ no   __ don't know

4. Is the use of CAI initiated by school authorities or teachers?

__ initiated by teachers   __ initiated by school authorities

Please comment on any change needed:

VI. Technical Aspects of CAI software

1. Which packages do you find most effective?

2. In the effective packages, which aspects about them are significant?

    a. what is the range of response allowed to the user?

    __ 1 answer possible   __ 2 - 5 answers possible

    __ more than 5 answers possible

    b. do they have a pre-determined number of questions which are asked of the learner, and whether a correct or incorrect anwer is given, the user moves on to the next question?

        __ yes   __ no

    c. what types of questions are used?

    __ T/F questions?   __ multiple choice?   __ matching

    __ short answers?   __ essay questions

    d. what kind of feedback is used?

    __ positive?   __ negative?   __ neutral, e.g., state score

3. What are the main types of presentation format used in the popular packages?

        __ drill?   __ test?

        __ inquiry, i.e., information retrieval type questions?

        __ simulation of a situation?

        __ tutorial CAI where the program responds to the
                learner like a teacher?

        __ games?

4. Does special effects in presentation improve the effectiveness of CAI software? Special effects include flashing, inverse video screen to catch users' attention.

      __ yes   __ no   __ don't know

5. Is graphics important?

      __ yes   __ no   __ don't know

Name some packages which successfully use graphics to present material?

Does enabling a student to draw on the screen help him to learn?

      __ yes   __ no   __ don't know

6. Are video or audio aids used also?

      __ yes   __ no   __ don't know

7. Is a record kept on the student's progress and is it presented to the student?

      __ yes   __ no

8. Do children depend on HELP structures like dictionary, glossary of terms or depend on the teacher for clarifications?

   depend on: __ HELP or support structure in the program

                  __ dictionary

                  __ teacher

9. Is there room for commenting on the student's part to make the CAI programs appear more friendly?

        __ yes   __ no

10. Does the software support diagnosis of student errors and remediation?

        __ yes   __ no

11. Do HELP structures help or confuse the student?

        __ help   __ confuse

Does he usually know whether he is in HELP structure, how to get out, or how to continue?

        __ yes   __ no   __ don't know

12. Is interaction of computer and non-computer instructional media most helpful for students?

        __ yes   __ no