Implementation of Microcomputers in the High School Geography Programs - the Ottawa Case

by

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A thesis submitted to
the Faculty of Graduate Studies and Research
in partial fulfilment of
the requirements for the degree of
Master of Arts

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Carleton University
Ottawa, Ontario
September, 1990

ISBN 0-315-68820-3

Abstract

At this stage of microcomputer use in Ontario secondary schools, the problem of effective implementation is not only one of appropriate design plans, but also one of application of these plans. This problem of effective microcomputer implementation is presented from a two-level theoretical perspective of curriculum implementation, i.e., the Ontario Ministry of Education and the school board/geography teachers' perspectives. The relevant issues discussed are: the ministry policy for introduction of New Educational Technologies (NET), the characteristics of the educational innovation, school boards' microcomputer implementation policies, geography teachers experience with, and interest, in using microcomputers for geography; frequency of use, applications, hardware/software issues, and teachers training. The research uses a case study methodology based on four boards of education in the Ottawa region. The results are compared with previous reports, interpreted in the light of existing implementation theories and summarized in a set of suggestions for administrators and teachers.

Acknowledgements

I would like to express my deepest thanks to my both advisors Dr. D.R.F. Taylor and Dr. Tom Wilkinson, for taking time to discuss problems and read my work. Without their guidance and advice this task would have been much more difficult.

I also wish to thank the geography supervisors at the four boards of education, and the educational officer at Merivale Road for their interest in my study, and readiness to provide information and help.

I am indebted to Karen Cughan, Dr. Charles Gordon and Dr. Gordon Deecker for editing this thesis.

Finally, I wish to thank you my mother, and my dear friends Steven Prashker and Alun Hughes for their trust, constructive criticism and moral support.

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Chapter I

How is Innovation in Education Assessed ?

The scope of the innovative technologies affecting education is broad, including telecommunications, computing and information technologies, commonly called telematics.[1] Technology is expected to be "the greatest thing that ever happen to education" [Coates 1984:41] and "a resource of scientific knowledge" [Green-Milber, 1986:1]. Telematics implies a range of media : film and television, radio and audiotape, videotape and optical disc, videotext and tele-conferencing, computer and computer-assisted instruction (C.A.I.). Each of these technologies has its appropriate application depending on the educational purpose. This study is concerned with only one of these innovative technologies in education - the microcomputers and their implementation in high school geography in the Ottawa region.

1.1 What is the Scope of this Study?

Microcomputers provide geography teachers with a new and powerful aid, which has much promise for teaching and learning. To date, however the studies on microcomputers in education have mainly focused on the questions of initial

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1 According to J.F.Coates [1984], 'telematics' is a new French word used as an umbrella term embracing all of the rapidly expanding and integrating electronically based technologies.

purchase, acquisition and adoption (Table 1.1), rather than on the implementation of microcomputers in geography. With respect to the intermediate and senior level geography, studies have concentrated on data-base use [e.g. Sounders, 1987; Brown, 1987], computer simulations [Howard, 1987; Griffith, 1987], computer mapping and graphics learning [Siliauska, 1987; Hughes, 1979]. While these studies indicate positive affects and experiences about teaching and learning, none reveal significant affect on the learning outcomes.

In Ontario, studies have concentrated on software development (e.g., Egerton, no date, Gillis,1986 and Pike, 1985); teachers' training (e.g., Lee, 1986); or on general issues of the new technology in Ontario schools, (e.g., Crosley, 1986: Solway, 1986 and a number of ministry reports, 1988). These studies provide little evidence about the way, the frequency and the intensity with which geography teachers are using microcomputers. Furthermore, there is no research-based knowledge about the changes in geography teacher practice despite more than ten years of effort to implement this new technology in Ontario schools.

It is argued that at this stage of microcomputer use in high school geography, the problem of effective implementation is not only that of appropriate design plans, but also one of application of these plans. Implementation[2] is critically important because it refers to the means of accomplishing desired educational objectives [Fullan, 1985]. Implementation is a development process of change for teachers attempting to use an innovation, which involves alterations in materials, instructional

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[2] Implementation is the second phase in the Berman's [1981] three-phase process of educational innovation: initiation (adoption), implementation and institutionalization (incorporation) Table 1.1.

practice and beliefs about the teaching/learning process (Figure 1.1). The extent and the quality of this change, which occurs (or fails to occur successfully) at the implementation stage, will significantly affect the outcomes to be achieved in any given change effort. Thus, without successful implementation (i.e. the appropriate integration of microcomputers into geography teaching/learning practice), no learning outcomes can be expected in the first place.

Because of the importance of the implementation process, the present study is designed to focus specifically on the stage of microcomputer implementation. It is hypothesized that the application of the microcomputer implementation plans have not reached adequate results in the subject area of high school geography. Thus, the actual use of microcomputers in high school geography in the Ottawa area high schools is still limited, and it is premature to speak of their effective implementation - utilization in the classroom. The goal of the study then is to investigate this problem of effective implementation from Goodland's [1979] two-level theoretical perspective of curriculum implementation (Figure 1.1):

1. The Design Level - i.e. strategic planning by the Ontario Ministry of Education, which strives for the ideal integration of microcomputers in the intended curriculum; and,

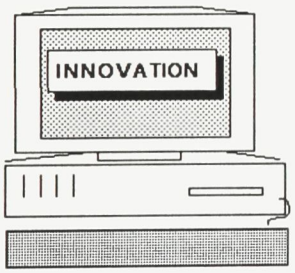
2. The Local or User level - i.e. school board and teacher level, where changes, including new materials, new instructional approaches in daily classroom practice, and beliefs are developed.

Table 1.1 Phases in School Innovation - Microcomputers

Phase	Important Activities	Relevant Research
Initiation - development or adoption	Planning and acquiring Microcomputers	Surveys of Adoption Rates Needs Assessments
Implementation	Installing, Implementing, and using Microcomputers	Implementation Studies
Institutionalization and other outcomes	Assessing Educational Outcomes from Using Micrcomputers	Evaluation Studies

[After Yin 1984 b and Fullan 1985]

Figure 1.1 Perspective on Implementation



DESIGN LEVEL	LOCAL or USER LEVEL
Strategic Planning for :	Alterations on:
Implementation	Materials
Utilization	Practice
	Beliefs

[After Fullan et al. 1988 and Goodland, 1979]

The rationale for this approach is based on findings in related studies [e.g. Fullan et al., 1987; Plomp and Akker, 1988; Yin, 1984] which indicate that the problem of effective implementation is not only that of a well designed plan, but also that of its effective use. Even the best acquisition plans at the design level can change, due to unanticipated events during the implementation phase at the local level. Yin [1984] suggests that when implementation proceeds smoothly, a new technology, such as the use of microcomputers, will become a part of "standard" practice. When implementation does not proceed smoothly, "the initial investments will have been wasted, and the new technology may literally end up in a closet" [Yin, 1984:4].

1.2 What is the Rationale for This Study?

The educational role of microcomputers is recognised by the Ontario Ministry of Education. There are two events regarding computers in Ontario education which are important to this study. The first focuses on the introduction of microcomputers as aids for teaching and learning in Ontario schools. This was first initiated at the end of 1970s and the beginning of 1980s. Ministry expectations involve sponsorship for development of domestic hardware and software design specifically for Ontario curriculum goals, as well as the integration of microcomputers in the student learning [Fullan et al., 1988]. The second event is conveyed through the new geography curriculum guideline for intermediate and senior divisions[3] for 1990 and 1991. This new curriculum recommends extensive use of microcomputers in geography, and introduces a new computer-use course - Geographics.

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[3] The Intermediate level in Ontario includes Grades from 7 to 10. The senior level includes grades from 11 to 12 and The Ontario Academic Courses (OACs) [Ministry of Education, 1988 p.2]

The educational role and the benefits of microcomputers for teaching and learning, as expressed in the new geography curriculum guideline, are to:

- Allow students to work in groups and promote their co-operation;
- Involve students in role playing and decision making;
- Help the teacher to move from the roles of authority figure and information provider to the roles of facilitator and consultant;
- Give students an increased measure of control over the pace of their learning;
- access data bases, to communicate with students in other locations, and to work simultaneously on tasks or simulations;
- Free teachers to use their time more productively by consolidating learning through tutorial or drill-and-practice exercises; and
- Facilitate the accumulation and management of data on student achievement. [Ministry of Education, Geography Curriculum Guideline, Part A, 1988:23-24].

Despite the variety of microcomputer use for teaching-learning geography, detailed evaluation of the computer-assisted learning outcomes have not been conducted. Major research efforts have been mainly devoted to observe and record the acquisition of hardware [Taylor and Cunniff, 1988], or to developing guides on how to acquire the needed hardware and software [Purdy, 1987; Rose et al. 1984]. The major reason for this research focus is that many schools in Ontario have just begun to integrate computers into the formal geography curriculum [Toronto-Canadian Commission for UNESCO, 1984]. Even though the number of microcomputers for class use per school in Ontario had increased from 14.5 in 1986 to 22.5 in 1989, a

large number of schools across Ontario concentrate almost exclusively on the use of word-processing and spreadsheet, rather than on subject-specific utilities [Ministry of Education, 1989].

With respect to high school geography curriculum, the ministry indicates the need for up-to-date information and warns that the traditional textbooks cannot provide the current information that geography studies demand [Ministry of Education, 1989]. One of the assumptions guiding the ministry's future policy decisions is that teachers need to use a variety of informational resources. The ministry found that willingness to use alternative resources is dependent on having available the materials and equipment, and the institutional support for research.

Despite this knowledge, the implementation of subject specific utilities, such as microcomputers for teaching-learning geography, is still low although there have been noticeable increases in the number of computers in Ontario schools. Due to this low microcomputer implementation rate, short term measurement of learning outcomes can not be expected.

Therefore, this research has a dual purpose. The primary aim is to assist school administrators in understanding the implementation process, so that potential pitfalls can be avoided in the future. This will be achieved by determining current needs of geography teachers for microcomputer implementation in teaching-learning, and by making suggestions to the policy designers and school board administrators and teachers. A secondary purpose is to identify the theoretical implications of the implementation process, so that research investigators can build further upon previous knowledge about the implementation of C.A.I. in educational programs.

1.3 Research Design

Following Goodland (Figure 1.1), the state of microcomputer implementation for geography teaching and learning at the Intermediate and Senior levels will be assessed by addressing objectives at both the ministry and school board/teacher levels.

The objectives of the study are to assess:

At the Design Level:

The Ontario Ministry of Education policies for microcomputer use in schools in general, and, for high school geography programs in particular;

Microcomputer innovation technology characteristics, which effect the implementation, including clarity, complexity, consensus, quality and practicality of microcomputers.

At the Local Level:

Board of education policy for microcomputer implementation and teachers' computer training;

The quantitative aspects of microcomputer use in geography, i.e., the frequency of use.

The qualitative aspect of microcomputer use in geography, i.e. level of complexity of microcomputer application.

Geography teachers' attitudes towards using microcomputers as a tool for teaching and learning in geography;

Geography teachers' computer training and training preferences;

The availability of hardware for the geography program and the function of the hardware;

The availability and appropriateness of software and courseware for the geography program; and software suitability in relation to the existing hardware.

These aspects cover the major concerns in dealing with the states of microcomputer implementation in the geography program. In addition, as will be discussed in Chapter VI, the questions also reflect prominent theoretical and conceptual issues regarding the innovation and implementation process in educational institutions.

1.3.1 Research Approach

Due to the nature of this inquiry, a multiple-case study design is the most appropriate methodology. The rationale for the multiple- rather than single- case study is replicational logic, i.e., if multiple cases of the same phenomenon yield parallel results, greater confidence can be placed in the results [4].

The multiple-case approach leads directly to the initial analytical task of defining the "cases" being studied. The Ottawa region has five boards of education. Four of them were selected as "cases", and independently investigated: the Ottawa Board of Education, the Ottawa Roman Catholic Board of Education, the Carleton Board of Education and the Carleton Catholic Board of Education. In order to strengthen the initial hypothesis, the four boards were cross examined, and the hypothesis revised. This research does not investigate the Francophone Board of education because of its very recent establishment [1988-1989]. However, the francophone board was contacted for general curriculum information. The major factor contributing to the choice of these boards is accessibility to the sites and the data.

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[4] Yin [1984] points out that in contrast, an incorrect rationale for multiple-case design is sampling logic, wherein the cases are presumed to represent some larger universe.

The relevance for using multiple-case design is based on the following assumptions. First, implementation is a phenomenon that is difficult to distinguish from its real life context, for example, from other organizational changes and conditions. Yin [1981a and 1981b] is of the opinion that in such circumstances case studies are more appropriate to use than surveys and experiments. Second, the case study is the preferred method when the process extends over time, such as the case with the implementation process [Yin, 1984; Fullan, 1985]. Third, previous research on the state of implementation has refined methods involving interviews, questionnaires, and content analyses, which are all used in a case study [Hall and Loucks,1977; Crandall et al., 1982]. And finally, as summarized by another group of investigators [Greenberg et al., 1977], case studies are an appropriate research strategy for topics, such as implementation, where implications are too complex for single factor theories and explanations, and, there is a large number of relevant participants.

The case study approach is not necessarily preferable in all possible circumstances. For example, only a survey will produce information on the adoption rate of microcomputers. Similarly, an experimental setting may be appropriate for measuring the learning outcomes of microcomputer use. However, neither of these strategies is as effective or appropriate as the case study for assessing the changes associated with the implementation process in the classroom.

1.3.2 Data Acquisition

Following Yin [1984:78] the acquisition of data in these cases makes use of multiple sources of evidence covering the same set of facts or findings. The data for the cases in this study are derived from:

A. Documentation, such as: formal studies or evaluations of the same study site; letters, memoranda and other communications. The most important use of these documents is to corroborate and augment evidence from other sources. Their use is not based on their necessary accuracy or lack of bias, i.e. the documents are carefully used and are not accepted as literal recordings of events that have taken place.

B. Archival records, including: telephone listings, lists of names and address. These records are used in conjunction with other sources of information used in this study.

C. Interviews in three forms:

- Open-ended interviews, in which the respondents are asked for the fact of the matter as well as for their opinion about events.

- Focused interviews, in which the respondents are interviewed for a short period of time. The purpose of this interview is to corroborate certain facts that have been established.

- Survey interviews (questionnaire), involving development of a sampling procedure and survey instrument. The survey is used as only one component of the overall assessment.

D. Direct Observations made throughout the site visits when other evidence is being collected. The observations provide additional information, and are especially valuable for collecting evidence on technology at work. The participants in the open-ended and focused interviews are:

- The Ontario Ministry of Education personnel responsible for the geography curriculum guidelines and computer resource centres;

- Board of Education personnel, such as: managers and consultants of computer services, planning and instructional services co-ordinators; special assignment teachers; and geography advisors.

- High school geography teachers.

The participants in the survey are all full-time high school geography teachers from the four boards selected as case studies. The questionnaire used as a survey instrument is found in Appendix A.

The analysis of this multiple case study uses explanation-building as an analytical strategy. In each of the four cases explanation results from specifying the causal links based on the initial hypothesis. The evidence for each case study is examined, the hypothesis is revised, and the evidence is examined once again from a new perspective. Then, the results from each case are used to create a cross-case analysis.

The quality of information in the case study is assured through three procedures :

> Construct Validity - where correct operational measures for data collection are established by following the principles of using multiple sources of evidence and the creation of a data base for each case. The data base includes the case study notes, documents, and tabular data sources such as questionnaires. The construct validity is met during the data collection stage.
>
> External Validity - where analytical, rather than statistical generalisation is employed (the later is typical for a survey research design). The particular set of results is not generalised automatically, but follows a replicational logic.
>
> Reliability - where by documentation, it is demonstrated that the operations of the study, such as data collection procedures can be repeated with the same results.

1.4 Thesis Organisation

This thesis is organized into several chapters which follow the flow from theory to practice, proceeded through a synthesis of both of these. Chapter II is concerned with the microcomputer, its role in education in general and in geography in particular. In Chapter III implementation is examined at the design level, i.e. the ministry policy for microcomputer use is introduced. In Chapter IV local level implementation is examined, the rationale for data collection is described, and the four case studies are presented. The analysis of teachers' interest and use of microcomputers is presented in Chapter V. Chapter VI is the concluding chapter where the results from the study are compared with results of other similar studies, and further implementation policy and areas of research are recommended.

Chapter II

Microcomputers and Their Implications for Teaching Geography

The purpose of this chapter is to discuss the role of the microcomputer as an aid for teaching geography in high school. The microcomputer is introduced as an innovational technology in education, and its attributes are outlined as speed, reliability, informational capacity, equipment compatibility and user control. Present misconceptions about the role of microcomputers in education are addressed, and the contributions of microcomputers to high school geography programs are presented in relation to the common teaching methods: lecture, reading, tutoring and tutorials, simulations and games, and writing assignments. In conclusion, directions for insuring better use of microcomputer in geography are suggested, and the roles of microcomputers in geography are generalised.

2.1 Microcomputer - Innovational Technology, Attributes and Myths

2.1.1 Innovational Technology

One of the major differences between microcomputers and other instructional media is that they have the capacity to allow cognitive interaction with the students, requiring their active involvement, and the capability to allow for individualized

instruction using interactive techniques [Moore, Nawrocki, & Simutis, 1979]. These, on the other hand, have many implications for the way teachers can use microcomputers.

Microcomputer systems for manipulating data, including programs, text, graphics, video, voice, sound and touch are rapidly improving, providing teachers with powerful new tools for interaction [Siliauska, 1987]. For example, the concept of interactive electronic book capable of supporting text, sound and animation, introduced by Goldberg [1979], is the base for the new types of optical and electronic book that are currently gaining significant popularity , e.g., Conklin [1987], Marchionini and Shneiderman [1988] and Barker and Manji [1988].

A widely accepted conceptual organization of microcomputer use in education is presented by Taylor [1980]. He suggests that a microcomputer in the classroom may be used as a tutor, tool or a tutee. The tutor mode refers to use of the microcomputer as an instructional aid, commonly referred to as computer-assisted instruction [CAI] in North America or computer-assisted learning [CAL] in the United Kingdom. The tool mode refers to use of the microcomputer as a production or management tool, such as word processor, spreadsheet or data base management. The tutee mode refers to the situation where the student gives instruction to the microcomputer by programming.

The Ontario Ministry of Education recognize the capacities of microcomputers for teaching and learning. The ministry promotes this innovation in all school subjects for all grades. The educational role and the benefits of

microcomputers for teaching and learning are discussed in the light of the new Geography Curriculum Guideline [Ministry of Education, 1988 (c,d)] in Chapter I, 1.2 and III.

2.1.2 Microcomputer Attributes

There are several attributes which make the microcomputer such a versatile technological innovation in education. Some of them, as outlined by Shepherd [et al.1980] are: speed, reliability, information capacity, equipment capabilities and user control. Speed refers to the thousand-millionths and million-millionths of a second that take the microcomputer to operate a basic operation. For easier contemplation imagine that it would take a person about 30 years to perform the same number of tasks that the computer would complete in just a single second [Shepherd et al., 1980]. It is for this reason that the microcomputer can release students from time-consuming, repetitive and boring work, allowing them time to concentrate more on the design, integration and evaluation of their work.

Reliability refers to the constantly high degree of accuracy with which the microcomputer performs its tasks. The microcomputer also allows the management of tasks which could not be contemplated with manual computation. The microcomputer can encourage students in the end product of their labours, by reducing the number of their operational mistakes. The upper limit on the precision with which microcomputers store numerical data and perform arithmetical operations will rarely trouble educational users.

Unlike human written memory devices, the microcomputer's external memory or informational capacity is exceptionally compact. Any information stored in that memory can be retrieved usually in a fraction of a second. From an educational point of view, this gives the microcomputer the ability to store all kinds of information - cartographic, numeric, textual - and makes it possible for students to search, analyze, map, or otherwise manipulate it, in a search for explanations or simulations.

Equipment compatibility refers to the microcomputer's capabilities to recognize the human voice, to scan maps and charts, to monitor laboratory and field equipment through appropriate interfaces, to plot maps, to detect handwriting and even speak by means of a speech synthesizer. Not all of these capabilities are in common use yet, and in educational circles the main means of communicating with the computer is through a keyboard and printer or video display unit.

One of the prime characteristics of the microcomputer is that of user control, i.e., it can store user-supplied instructions. Programmability means that microcomputer resources can be turned to almost any educational task, as long as the appropriate instructions are available. Together, these attributes make the microcomputer an immensely valuable resource for teachers.

2.1.3 Myths

The use of the microcomputer in education is increasing so vigorously that it has fast become a part of the instructional media in most schools [Jarolimek, 1986]. However, critics point to the absence of meaningful computer activity in the schools as an indication that misconceptions about the computer technology in those

institutions are hampering the response to the needs of the changing society [Shepherd,1985; Hannafin et al.,1988; Reed, 1986, etc.]. Swadener and Jarrett [[1986/87] compiled a list of current uses of computers in secondary schools and found the uses were very specialized and isolated [in Hannaford, 1988]. Hannafin et al. [1988] point out that with the exception of administrative applications, computers have had little impact on instruction, other than instruction about computers, in most school systems.

A summarizing view on the literature on microcomputer misconceptions in schools indicates that the most common of those misconceptions is concerned with: -

Time, e.g., "the computers can save time" pointed out by Shepherd et al. [1985], or "Teachers are too busy to deal with computers as an additional responsibility" elaborated by Tetenbaum and Mulkeen [1986];

- Cost of computers, e.g., "computers are too costly compared to text books" discussed by Papert [1980] and Bork [1986], and "computer-assisted instruction is not cost-effective" implying that computer assisted instruction is too expensive to be utilized on a significant basis, commented on by many, including Hannafin et al. [1988], Yin et al. [1984], Bangers-Drawns et al. [1983]; and
- Access to computers, as well as the educational values of computers,e.g., "computers are useful for teaching only low level skills" [Reed, 1986 and Hannafin et al., 1988], the effects of using computers on student performance and motivation for learning.

The phenomena of myths which surround a new technology is probably not unique to the school systems only. Microcomputers as tools for teaching and learning, even though in continuously increasing number in the schools, are still in a stage of exploration. In this stage, the misconceptions about their educational use can be a barrier to understanding, or to desirable progress, and require educators' awareness.

2.2 Teaching Methods and the Use of Microcomputer.

The environment of teaching has seen various technological innovations, beginning with the utilization of writing through the chalk and the black board, to the use of film, over-head projector, tv screen, and, in recent years, the microcomputer. In comparison to this dynamic range of innovations, teaching methods have sustained fewer changes. Therefore, the following review of the educational role of the microcomputer in geography organises the styles of microcomputer use in relation to the teaching methods commonly used in secondary education.

The influence of microcomputers and other electronic technologies is beginning to be felt in the classrooms, and during the next five to twenty years their impact will be massive. What are the implications of the microcomputer for social studies in general, and for geography in particular? De Leeuw and Waters [1986] argue that unless the role of the microcomputer manages to serve the goals of social studies it may reduce the effectiveness of this field. They stress that little attention has been given to adapting teaching methods to microcomputers and that few computer specialists appreciate the needs of Social Studies education. There is

little time to prepare as the 'computer revolution' is already affecting the schools. This is the reason for the further focus of this chapter on the educational potential of the microcomputer for geography.

2.2.1 Lectures

Giving an instructive talk before the class is a widely accepted method of teaching in secondary education. The new electronic technologies can be employed in the course of lecture delivery in two ways. The first way is teaching *by* computer, where video recorder, film projector and tape-slide system combine high quality visual and audio output, pose a great threat to "stand and deliver" [Shepherd, 1985]; this is even more true as laser vision and videodiscs become more common place.

Teaching *with* the computer is an alternative way that can be employed in the 'stand and deliver' lecture. Many authors [Gibbs & Jenkins, 1984; Phillips, 1982; Taylor, 1987] emphasize that the microcomputers enhance and provide variety in the standard lectures by providing graphical displays, running simulations, recalling information, analyzing stored data, animating static maps or diagrams and so forth. The use of short simulations on the microcomputer during the lecture can breathe much-needed life into static or forbidding formulae or expose the poverty of models, e.g., about for example cloud formation, ocean streams or volcanos, assumed by students to be 'the truth' [Sumner, 1984].

A computerized atlas or map can be a frequently used teaching aid during a geography lecture. Computerized atlases allow students to manipulate a globe on the screen, to zoom in, and to request factual information on population, capital

cities and currencies in addition to geographic and political boundaries [1]. Even though it is unlikely that Geographic Information System (GIS) data bases and spatial mapping packages are available in high schools at the present time, de Leeuw and Waters [1986] are of the opinion that computerized atlases are likely to be an increasingly common resource for teaching by the mid-1990s.

Lecture preparation is another task where the microcomputer's spreadsheet programs, word processor and graphics packages can be very successfully employed. For example, all of these programs can be used for producing hand-outs, and reading lists, and as indexing and retrieval facilities for teaching resources [Shepherd, 1985].

2.2.2 Reading

Reading is usually required from the students in order to fill in the gaps left by lectures and to broaden intellectuals perspective on a subject. The microcomputer can help the students to do this by providing support for existing reading activities in two ways: as a retrieval system; and as a book substitute.

As a retrieval system, different data bases within the microcomputer can be used for a bibliographical search. For example, the Educational Research Information Catalogue [ERIC] stored on several optical disks provides an excellent source of information on education-related articles and their location. Using the microcomputer as a retrieval system for tele-referencing is a common contribution of the microcomputer to reading. "Help" software can also provide on-demand guidance to the students on how to consult certain bibliographies [Shepherd, 1985]. Such type of software can also teach students to be more proficient when using

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[1] For example "Atlas" - Software Concepts and "Atlas Explorer" - Springboard.

library, dictionaries, card catalogues, atlases, encyclopedias and magazines through the use of program, e.g. "Discovering the Library Package" - Focus Media.

The electronic book is a less common, but increasingly popular, contribution of the microcomputer to reading. Different software packages have been designed for this purpose, some acting as a 'page turners' only, some as a full-text database systems. Shepherd [1985] states that recent developments in the field of electronic publishing promise a revolutionary view on the printed page, and respectively a profound impact on student reading activities. Already the growing amount of textual material available for consultation on Videotex services, electronic bulletin boards and electronic mail systems is making an impact in business circles. It is just a matter of time before students will be able to consult electronic journals and books. For example, a successful information exchange on geographic, historic and personal data between two schools using telecommunication is already reported by Bear [1988].

2.2.3 Tutoring and Tutorials

Opposed to the 'passive media' of lecturing and reading [Kay & Goldberg, 1977], the one-to-one interaction between a teacher, a student, and the small group is an 'active' medium. Tutoring and tutorials can be used as an adjunct to lectures to provide individual tuition, or to identify student's difficulties.

The microcomputer's ability to run individualized instruction causes tutoring to be perhaps the most appropriate teaching method for microcomputer application. Although impressed with the technology, many teachers become disappointed as they realize that the software has not been sufficiently developed

with current educational theory and practice in mind [Plowman, 1988]. Some of the problems in creating geographic courseware that can reason about objects and events in space are stated by Shepherd [1985]. Among others, he emphasises the difficulty of representing geographic knowledge within a microcomputer, the communication problem of the student's graphical and verbal languages and the problem of constructing a model of the student's learning for use as a guide to the tutorial program.

Recently, however, the increasing area of intersection between the fields of artificial intelligence (AI) and the educational technologies, the advances in computer, interactive video (IV) and compact disk technology are giving much promise in the area of computer-assisted instruction (CAI). The ultimate goal is the creation of intelligent CAI, which "is effective in learning fact, theories and taxonomies using different approaches, assuming different points of view, choosing a desired level of detail, focusing on selected aspects of the theory" [Midoro et al., 1988:308]. The same group of authors proposes an example of such flexible/adaptive system - "Earth", where plate tectonics can be approached from historical point of view, or the user can choose to learn the basic concepts of this theory, or concentrate on learning tectonics of a particular area. This approach has much promises for the future development of intelligent CAI, and at the same time points out the need for more research in the area of basic aspects of learning and teaching [Midoro et al., 1988 and Backer, 1988].

2.2.4 Simulation and Simulation Games

Simulation is considered to be one of the first teaching methods almost entirely converted from manual to computer-based operations [Shepherd, 1985]. Computer simulations have wide application in physical and social geography. Some examples of courseware with such applications are "Lifestyle" - Unknown, "Life Expectancy" - Unknown, "Water" - Gilbert and Friedland and "B.C.Lumbering" - Buckley, Donald and Szeto. The educational advantage of computer simulations is that they allow students to isolate and examine environmental processes in more productive ways than by their direct examination in the real world [Yates, 1980], or by intensive study of empirical data [Unwin, 1981]. Some of the most popular simulation games for geography are: "Cargo Sailer" [Ontario Ministry of Education], "North-West Fur Trade" [J.J. and J. Enterprises], "Offshore Fishing" [The Associates of Large School Boards of Ontario].

There are three stages in the use of computer simulations: exploration, experimentation and calibration [Kirkby & Naden, 1988]. The first stage consists of answering the question 'what if...?' In this stage the student adjusts the variables to create a predictable response and to get a general understanding of how the model works. At the next stage of learning the student performs a controlled experiment with the model in order to get a deeper understanding of how individual processes behave. The controlled experiment shows the student which parameters have a significant influence on the chosen outcome, so that the latter can be forecast. At the calibration stage, the model is fitted to a particular data set. Here, the student attempts to create a system which replicates a known real-world feature.

Simulation games are valuable for the introduction of the decision-making process in geography, as indicated by many authors [Taylor, 1971; Taylor & Walford, 1978; Walford, 1981]. Simulation gaming is a method of teaching that explores problems from the viewpoint of the individual student through the use of games [Griffith, 1987]. The educational game is the representation of any situation in which there are opposite interests between its players (the players and/or the nature), and which promotes the learning of certain skills by its players [Gould, 1963]. The popularity of simulation games in geography is attested by a set of papers on this subject [Howard, 1987; Griffith, 1987, Burt & Butcher, 1986; Walford, 1981; Conolly, 1981].

Computer simulations and simulation games are based on the principle that play and active involvement are beneficial to learning [Howard, 1987]. Both have rules, but whereas in the simulation games the participants can often remain outside the game, in a computer simulation they have a central role. However, in order to ensure successful participation of all students in the computer-simulation, students must have sufficient access to microcomputers, and adequately designed briefing and follow-up instructions from the teacher. Without these pre-requisites, as stressed by Shepherd [1985], the use of computer simulations and computer-simulation games '...can degenerate into mere recreation or mindless key-pecking' [Shepherd, 1985:12].

2.2.5 Written Assignments

The function of written assignments is to encourage and/or test a student's ability

to synthesize facts, concepts and opinions [Shepherd, 1985]. Different software can be helpful to the student in this task: data bases, spreadsheet, text editor, word processor and spell-checker.

An electronic data base is a computerized filing system. The software manages and manipulates textual and numerical data stored in the electronic data base. It has the capability to perform functions such as: store, sort, select, calculate, update, summarize, combine etc.. There are several purposes for using an electronic data base [Hunter, 1985] in geography: discovering commonalities and differences among groups of events or things, analyzing relationships, looking for trends, testing and refining hypothesis, up-date and arrange information. The student's critical thinking skills develop in the process of creating and working with a data base.

An electronic spreadsheet is an array of cells displayed as a work-sheet composed of rows and columns identified by numbers and letters [Lee & Soper, 1987]. Values are calculated automatically according to inserted formulas, and can be easily changed or put into a new table format and printed on paper. Geography students can use the spreadsheet to calculate and project data from various sources. For example, numbers related to population, trade, income and production in a spreadsheet form, permit calculations made on 'what if...?' scenarios.

In addition, different software has been designed to help students explore their writing skills in depth, arrange their material accordingly, and write unified essays, e.g., "Modern Writing Skills" - Aquarius, "MECC Outline" - MECC, and "Explore-A-Series: Science" - P.C. Heath.

2.3 Conclusion

The microcomputer is one of many electronic technologies making its way into the sphere of education. The microcomputer is presented in the light of innovative technology, with valuable attributes, and common misconceptions surrounding its educational role. Present and future contributions of the microcomputer in high school geography are highlighted, in conjunction with the commonly employed teaching methods. Some general reflections on the role of the microcomputer as a teaching aid in geography, and some suggested direction teachers may take to ensure the best use of this technology in geography teaching, will form the concluding comment of this chapter.

First, teachers often have exaggerated expectations of what the microcomputer can do in the classroom. The microcomputer does not relieve the teacher from any responsibilities, and should not automatically replace existing teaching methods. The teacher must still plan the sequence of learning activities, collect appropriate resource materials, and evaluate the learning.

Second, teachers must initially address their own concerns about the microcomputer and become comfortable with the various ways in which the computer can be used. Geography teachers need to be familiar with software packages, at least enough to read and understand them. The teacher should view the microcomputer as an aid that, firstly, makes learning more challenging, and then the challenge will

not be how to use, but how to incorporate labour-saving tools and valuable information into the geography curriculum.

Third, a considerable amount of research still has to be undertaken in order to determine which computer-based learning methods are the most effective for the particular parts of the geography curriculum. Shepherd [1985] is of the opinion that the exploration of the new technology should be guided by the educational objectives set for the courses, not 'technology driven'; on the other hand, however, the new educational technologies give new horizons in determining the educational objectives.

Fourth, the role of the microcomputer in any school depends upon the aims, expectations and computer experience of the teachers, the school organisation, and the available resources. The microcomputer has a varied role in teaching and it is a particularly versatile teaching aid for geography, despite the above mentioned reservations. The microcomputer provides labour-saving assistance and facilitates student activities, such as time-consuming manual calculations and analysis. It can assist the student in developing higher level thinking skills. The microcomputer is able to simulate real-world processes and forms, and to illustrate the forecasting implications of a particular set of assumptions.

Microcomputers have penetrated into the sphere of education as teaching aids, but it will take time to show actual improvement in teaching and learning. Part of the problem lies in the availability and accessibility to good quality hardware, and

software appropriate to the teaching of the subject. But a significant part of the problem of microcomputer integration into the curricula lies in the level of teachers awareness, interest and adoption of technological innovations. This is the reason for the focus of the next chapter on the implementation of technological innovations in education - in general, and in geography - in particular, as perceived by the Ontario Ministry of Education.

Chapter III

Microcomputer Implementation Policy at the Design Level - Ontario Ministry of Education

In this chapter, recent changes in Ontario school education concerned with microcomputer implementation, and the new geography curriculum are introduced. The ministry policy for introduction of New Educational Technologies (NET) in Ontario schools is discussed by emphasizing four aspects of ministry microcomputer implementation policy: technologies, products, user groups, and expected uses. Several ministry policy statements are reviewed and their expectations regarding the educational uses of microcomputers are summarized. The ministry's specific policy for microcomputer introduction in geography curricula, as expressed in the new guideline [Ministry of Education, 1988 (c) A:23-24], is examined. Microcomputer characteristics are considered as factors which affect ministry policy for NET implementation. Here four major factors are considered, including: clarity, complexity, and quality/practicality of microcomputers, and the extension of consensus among teachers and school administrators. Finally, the general ministry policy for microcomputer introduction in schools and the specific ministry actions for introducing microcomputers in the geography programs are assessed.

3.1 Microcomputer Implementation in Ontario

During the 1960s and 1970s, computers in Canada were acquired by large educational institutions and research organizations [Tobin and Sharon, 1984:6]. Since the early 1980s, microcomputers have been gradually introduced into Canadian schools. The planning of microcomputer development in education raises the questions of hardware and software acquisition, teacher training, budgeting, and equitable distribution. In Canada, where education is a provincial responsibility, the planning and decision-making are conducted independently in each province [Tobin and Sharon, 1984:19]. Only the Yukon and Northwest Territories are under federal jurisdiction for education funding [Fullan et al., 1987].

The focus here is on the Ontario Ministry's plans and decisions regarding implementation of microcomputers in Ontario schools, and the steps and direction taken for introduction of microcomputers in the geography program. Wilton [1986] stresses the need to survey the policies and initiatives of the Ontario provincial government with reference to geography as a discipline, and the broader topic of cross-curriculum computer use in schools, because the two are inter-dependent and also depend to a great extent on the support given to cross-curricula applications in all subject areas in the province. Also, the official attitudes might provide the framework within which the future use of computers in teaching and learning in geography can be projected.

The Ontario Ministry of Education is considered by many to be a leader in the integration of microcomputers across the curriculum (e.g. Wilton, 1986; Fullan et al., 1988; Tobin and Sharon,' 1984). In major statements and policy papers, the

ministry has indicated to the local school boards that computers are to be used by all students, not just for courses involving study about computers. Rather,

> "Students will use these machines to do a variety of activities - analysis and reasoning exercises;
>
> Simulation ... word processing.. graphics" and
>
> "There will be two fundamentally different ways to use computers in the process of teaching and learning. The more significant way will be the creative use of computers by individuals: writing, composing, designing, analyzing and other extensions of original thought. ... All students must be given the opportunity to use computers in this way" [Ministry of Education, 1982 (b)].

In order to place the succeeding analysis into an historical context, a chronology of some key Ministry decisions regarding those two changes follows :

Ministry Initiatives - Chronological Summary

1979 Identification of the need for NET support in schools.

1981 Decision to support development of an educational computer, and the formation of a Canadian company to develop the microcomputer.

1982 The goal for microcomputer creative use issued.

First Request For Proposal for an 8-bit computer software development.

1983 Hardware specifications - Stage I published.
New Computer Studies Guideline for Intermediate and Senior Divisions issued.

Recognition of ICON as a Grant Eligible Microcomputer system (GEMS).

1984 Formation of the Educational Technology Division at Ministry; and Ontario Educational Software Service (OESS)

Development and distribution of Ambience user-interface; and 55 pieces of software (Exemplary Lessonware Project).

Recognized Extraordinary Expenditure (REE) grants made available to school boards for purchase of GEMS.

1985 Software development for GEMS and REE grants continues

1986 IBM compatible machines approved as GEMS

Hardware specification - Stage II published

New Geography Curriculum Guideline for Junior and Senior Divisions - in draft stage.

1987 Policy statement summarizing Ministry expectations regarding NET use in schools.

Hardware grants for GEMS ($31 million).

1988 Continuing software development and distribution.

Hardware grants for GEMS ($43 million).

Software grant to the boards of education ($3 million).

New Geography Curriculum Guideline for Intermediate and Senior Divisions distributed - Parts A,B,C,D and F.

Payments to boards for purchase of commercial software

1989 Hardware grants for GEMS ($53 million).

OESS Software development and distribution continues - 144 software packages developed, and 31 in progress.

Software grant to the boards of education ($6 million).

1990 Part E of the New Geography Curriculum Guideline for Intermediate and Senior Divisions distributed, as of March, 1990.

Hardware grants for GEMS continue to increase to $65 million, or $54 for each elementary and secondary pupil.

Software grant to the boards of education decreased to $4.9 million.

Distribution of 167 Ambience software programs.

ATARI and OLIVETTI products approved as GEMS, as of May, 1990.

1991 The annual grant for GEMS is reconsidered and reduced to the initial amount of $31 million. [Fullan et al. 1988, Ministry of Education, Ontario, OESS 1989, information from interview with Hurtubise G., Feb. and April 1990; Ministry of Education, from materials presented at the Eastern Ontario Regional Advisory Committee Meeting, April 6, 1990].

3.1.1 Aspects of Ministry NET Implementation Policy

The ministry's approach to the introduction of NET in Ontario schools was examined by reviewing a number of policy memoranda and announcements[1], and by interviewing ministry officers. There are four current aspects of the ministry's implementation policy viewed from a contemporary and long-term perspective (Table 3.1).

A. Technologies.

The Ontario schools have been involved with microcomputers since 1980. The kinds of hardware first acquired were 8-bit machines, such as Commodore 64s, Apple IIs and PETS in the early 1980s. The following period is characterized by a constant increase in purchasing more powerful (16- and 32-bit) hardware. The ministry reports (Figure 3.1) that for *secondary schools*, there is constant growth in the number of Grand Eligible Microcomputer Systems (GEMS (1A)[2] (e.g. from 8,970 in 1986 to 20,937 in 1989); that the number of GEMS (1B) and other kind of microcomputers is also growing, (e.g. 997 in 1986 to about 8,474 in 1989).

The number of first generation 8-bit microcomputers is experiencing slight decline

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[1]The complete list of these materials is in the reference list under the heading "Ontario Ministry of Education Officials and Source Documents".

[2]GEMS (1A) are microcomputer work stations linked to a file server (e.g. the network requires only one software package to be loaded). GEMS (1B) are "stand alone" units, less powerful then GEMS (1A) and are usually used when GEMS (1A) are not practical, such as for library search, tele-referencing, or for key boarding courses.

Table 3.1 Ontario Ministry of Education Focus for NET Implementation

	CONTEMPORARY GOALS	FUTURE GOALS
TECHNOLOGIES	Microcomputers and Curriculum Software	All Types of New Educational Technologies (NET)
PRODUCTS	Grant Eligible Microcomputers (GEMS) and Software Distributed by the Ontario Educational Software Service (OESS)	Any Microcomputers and Educational Software
USER GROUPS	Teachers Using or Planning to Use GEMS and OESS Materials	All Teachers
EXPECTED USES	Use to Support Creative Learning and Provincial Curriculum Goals	Any Use Educational Process

[After Fullan et al. 1988]

from 19,940 in 1986 to 19,441 in 1989 [Ministry of Education, from materials presented at the Eastern Ontario Regional Advisory Committee Meeting, April 6, 1990]. Each of these systems requires its own software which is usually commercially produced outside Canada, and not keyed to the Ontario curriculum.

B. Products.

Grant eligible microcomputers (GEMS) and software distributed by the Ontario Educational Software Service (OESS) - represent the ministry's decision in 1981 regarding financial aid. The ministry also subsidized[3] the development of a more powerful microcomputer ICON (16- and 32-bit) specifically designed for educational use. There were over 11,000 ICONs in the 5,500 Ontario schools at the end of 1985 [Wilton, 1986]. This development included the design of compatible software appropriate to the Ontario goals of education and curriculum guidelines.

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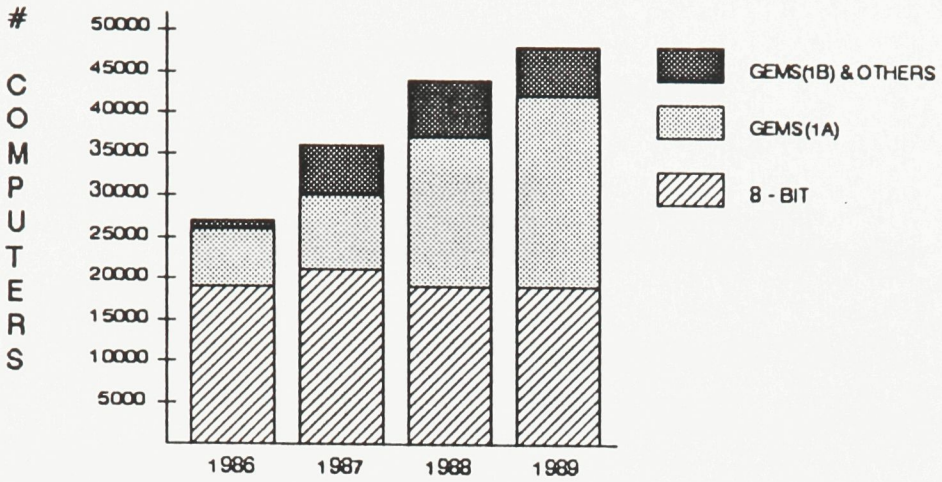
[3] The development of a new microcomputer for education is subsidized through private industry within Canada [Wilton, 1986]; Fullan et al., 1987].

Figure 3.1 Microcomputers in Secondary Schools



[After the Centre of Curriculum Research and Technologies, Ministry of Education, 1990]

In early February 1986, the ministry approved IBM, COMMODORE, APPLE - MAC II CX and TANDY machines to be also eligible for grants (Table 3.2). For these machines, an important upgrade, such as Ontario Approved Educational Microcomputer [OAEM][4] was required. Prior to the completion of the first OAEM, a call for software proposals resulted in the funding of 42 software packages for PET and Apple computers [Wilton, 1986]. After the approval of more OAEMs in 1986, all subsequent development, $5.7 million in 1985 [Wilton, 1986] is to meet the specifications of those machines. It should be noted that even though the ministry grant support only GEMS, they not prohibit the school boards from purchasing other brand microcomputers.

The ministry supports the development of software for GEMS through co-operation with the private industry. The ministry has developed and provides an Educational Applications Software Interface (EASI), (i.e. a specification list with requirements for educational software), to the provincial licensees for GEMS.

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[4] The name "Ontario Approved Educational Microcomputer" was changed to Grand Eligible Microcomputer Systems in 1986.

Table 3.2 Current G.E.M.S. Vendors and Their Products

APPLE	Quest family Macintosh IIx (Motorpla 680x0 based) Macintosh IIcx
COMMODORE	Comlink family PC10, 20, 40, 60 (Intel based, MS-DOS, Lanware) Amiga 2000 (with XT card, i.e. MS-DOS system as above)
IBM	EDNET Family PS/2 Model 30, 60 (Intel based WMI Port, not PC-DOS) AN/CLAS family PS/2 Model 30, 60 (PC-DOS, Watcom KX, Novell Netware)
INTERTAN (Tandy)	edLAN family Tandy Model 4000LX and 1000TL based (Intel based MS-DOS DesQview, etc.)
UNISYS	Icon/Lexicon family Icon II (Intel based, QN X 4x)
ATARI	GEMnet Family extended MS-DOS based system
OLIVETTI	Archimedes - 1A Family proprietary architecture based

[After The Centre for Curriculum Resources and Technologies, Feb. 25 and May 1, 1990]

The distribution is accomplished by OESS, which had approved and distributed 167 Ambience[5] programs for all grades as of March 1990; there are 89 packages for Intermediate Divisions, and 84 packages for Senior Divisions [Ministry of Education, from materials presented at the Eastern Ontario Regional Advisory Committee Meeting, April 6, 1990]. The ministry has given grants to the boards for the purchase of the domestically developed software, including $3 million in 1988, $6 million in 1989, and $4.9 million in 1990 (these amounts are subject to annual

[5] Ambience programs are OESS approved programs with interfaces on the ICON machines.

revision). As of 1988, the ministry supported the boards for the purchase of commercial software to augment current school software libraries [Ministry of Education Computer Initiative Funding Alternatives, 1990].

Ministry support for NET implementation follows its guidelines on hardware and software development and focuses mainly on the implementation of GEMS and OESS materials. In the long range the goal is to provide a sufficient number of microcomputers to allow access of 30 minutes, every day, to every student, (i.e., three to four microcomputers per classroom) and about 830 software products covering all areas and levels of Ontario curriculum [Fullan et al., 1988].

C. User groups

The target population for implementation assistance is the teachers using or planning to use GEMS and OESS materials. Teachers who do not yet have access to GEMS in their schools, or who have access but remain undecided about their use, are regarded as potential users (Table 3.1). In the long range, the implementation target population includes all 104,720 school teachers in 180 school boards [Ministry of Education, Ontario, 1988 (e)].

D. Expected Uses

The microcomputer is expected to support students' creative learning, and the provincial curriculum goals [Ministry of Education, Ontario, 1982 (a,b)]. The creative uses of computers include problem solving, writing, designing , etc., whereas the most common uses are for drill and practice, information retrieval and computer

literacy, which are regarded as secondary goals. The approval of hardware and software is made with regard to this creative learning goal. In the future, however, microcomputers are expected to support all teaching and learning activities.

3.1.2 Ministry Expectations Regarding the Educational Uses of NET

These expectations are stated in several policy statements focused on the distribution of government-approved hardware and software. It is important to note that the policy statements do not provide specific guides for teacher and student use of NET, but rather clarify the ministry's general expectations. They can be outlined as following:

- Increasing numbers of 'stand-alone' microcomputers in the classrooms [Ministry of Education, 1982 (b)]. Students will use the microcomputers for a variety of activities in two fundamentally different ways: common uses of microcomputers, such as drill and practice, accessing information and learning materials, which are regarded as a secondary goals; and the creative uses of the microcomputer accessible to all students for various extensions of original thought, which are underscored.
- Autonomy of individual learning will be ensured and facilitated by the microcomputer [Ministry of Education, 1983 (b)]. The microcomputer will serve as an aid to individual learning and will be readily available in every classroom. It is believed that the best arrangement will be clusters of microcomputers in a small classroom. Gradually, the network will be expanded to 30 or more microcomputers in different classrooms or in a single 'computer laboratory'.

- Ontario Educational Software Services [OESS] materials will be readily available and accessible through a new user interface [Ministry of Education, 1985]. An opportunity to explore the potential of the new materials, particularly the 'write' (e.g. word processor and spelling checker) and 'draw' (e.g. graphical packages) functions, will be given to all students.
- The opportunity to become knowledgeable and creative in the use of computers as personal tools shall be given to all students. The developers of the curricula should include appropriate computer applications in the areas of study defined in The Formative Years [Ministry of Education, 1987].

The expectations (A) and approaches (B) to implementing microcomputers in the schools are comprehensive, and summarized as follows:

A The curriculum at all areas and at all levels will integrate the use of microcomputers and software;

All students will be enabled to use microcomputers to corroborate the flexibility and autonomy in learning;

B Ministry of Education sponsors the development of the in-house microcomputer (ICON);

Ministry of Education funds the development of software appropriate to the official curriculum goals and policy (Ontario Educational Software Services (OESS) materials); and

Ministry of Education supports teachers who already use or plan to use GEMS.

3.2 Ministry Steps Towards Integration of Microcomputers into the Geography Curriculum.

A new geography guideline from which school boards should develop their courses was distributed in 1989. Consistent with the overall ministry statements, the

guideline incorporates more specific directions to teachers and school boards for the integration of computer use for the support of teaching and learning in the geography studies.

> "Geography teachers are innovators, not only in terms of classroom practices and out-of-school activities, but also in the use of a variety of equipment and media in the classroom. The advent of the computer into schools provides geography teachers with a powerful tool to achieve the aims of geographic education" [Ministry of Education, 1988 (c) A].

The ministry expects that school boards will use the guideline to review, develop, and implement programs and courses of study. The pervasive theme of the guideline is the importance of adopting classroom practices that meet the needs of learners and that reflect the current knowledge about learning. In accordance, the guideline provides a detailed description of computer uses in geography classroom practice, summarized as follows:

> A. Maps and Graphs
> Microcomputer technology allows for gathering cartographic data in an increasingly efficient way. The computers make it easy for students to experiment with ways of presenting data meaningfully without spending undue time in handling data, trying out layouts, and erasing errors. As a result, students have more time to consider the significant questions raised by the data. In addition, computer graphics make it easier for students to visualize two and three dimensions from plan views.
>
> B. Simulations and Models
> Simulations and models help students to identify the essential components of a process, system, or situation and to arrange them in ways that clarify relationships and interactions. Computer programs enable students, in very brief spans of classroom time, to work with the components or variables in a simulation, assign values to them, manipulate them, and then see the results of their actions. Teachers should see the potential that simulations and models hold for dealing with curriculum topics such as environmental management, locational decisions, and economic development.

C. Data Bases

> Computers have the capability to store large amounts of information, as well as to display it in forms that allow it to be used in various combinations. Studies in geography should help students to acquire skills in the collection, organization, entry, accessing, and use of the data. Of particular importance are the skills associated with the posing of questions that can be used to recall data in various forms to show relationships, patterns, and trends. [Ministry of Education, 1988 (c) A:23-24].

A new course - Geographics - is proposed for introduction at the Ontario Academic Courses (OACs) level in 1991 [Ministry of Education, 1988 (d) E]. This course is intended to provide a global viewpoint on some of the major issues in the contemporary world. It is stressed that in this course "... students must have access to electronic technologies to program such operations as the following in a relatively short time: accessing data bases; creating maps, charts, and graphs; using spreadsheets "[Ministry of Education, 1988 (d) E:33].

The new guideline stresses that the representatives from the school boards and schools should hold specific responsibilities during the guideline implementation stages. The responsibilities at the school and board levels for guideline implementation include: an action plan taking into consideration the available resources, the required equipment, and teacher training. Some of the same responsibilities, at the school level and within the organizational unit of the school, include the allocation of time, resources, and teaching staff, the acquisition maintenance and use of equipment and learning materials and professional development [Ministry of Education, 1988 (c) A:29-30].

The guideline advises teachers on the uses and the potential of microcomputers for teaching and learning geography. The benefit of using microcomputers when the educational tasks are concerned with maps and graphs, geographical simulations and models, and data bases are specifically stressed. However, the guideline does not advise on the intensity (how long?), frequency (how often?) and on quality (what kind of courseware, e.g. simulations, drill and practice programs) of software packages. There are no suggestions about what software to use for particular topics, or for each grade in general.

The geography teachers' resistance to develop independently the course units from the guideline was indicated by Geography advisors[6] [Curriculum Advisory Committee Geography, meeting in Kemptville, April 25, 1990]. They, however, could not agree whether the geography teachers should be expected or should not be expected to individually develop lesson units. This could be explained by the widespread attitude, especially among long-experienced teachers, that the ministry should provide close directions and lesson materials. Regarding the implementation of Geographics, the Geography Advisors are of the uniform opinion that the course requires, besides the regular access to equipment, special teacher qualifications. As a result, the advisors expressed uncertainty about implementation of the course in the next few years [Curriculum Advisory Committee Geography, meeting in Kemptville, April 25, 1990].

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[6] These include the advisors from the Eastern Ontario Region with 18 school boards [Directory of Education, 1988]

There is also no information about the availability and the benefits of the OESS geography software for the Junior and Senior Divisions. Even though the use of microcomputers for all school subjects is a ministry goal, the ministry reports and case studies suggest that until now, microcomputers are far from being a part of everyday geography school practice [Wilton, 1986; Toronto-Canadian Commission for UNESCO, 1984; Tobin and Sharon, 1984].

3.3 Characteristics of the Implemented Technology

While discussing implementation at the policy design level, it is necessary to turn our attention to the characteristics of the innovation being implemented. These factors and associated processes have a direct effect on the degree of implementation and the quality of use, as indicated by Rogers and Shoemaker [1971]. Four main factors or characteristics are identified in several major research studies: clarity; complexity; quality and practicality of materials [Crandall et al., 1982; Emrick and Peterson, 1978; Louis and Rosenblum, 1981].

A. Clarity

For successful implementation, a clear understanding of what to do and how to put the innovation into practice is needed. This is why policies, written guides, in-service programs, and participation in microcomputer development help clarify the meaning of the change for those involved. Ministry officials emphasize that there is still great uncertainty about student outcomes and about effective organization and use of the technologies in schools, as stressed by Fullan et al. [1988]. Particularly, there are uncertainties about microcomputer use to support creative learning. The ministry sees a need to foster variation in the initial use, and to identify the effective uses of

microcomputers through research. There are needs of school personnel for clarity about the implementation of GEMS and OESS materials. The ministry responds to these needs mainly by giving policy/program memoranda and statements about computer applications in the guidelines (such as the new geography curriculum guidelines); as well as by controlling the characteristics of hardware and software. For example, the objectives of the ministry hardware and software development strategies are to standardize the equipment and materials in the schools and to make technologies as easy-to-use as possible for the teachers and student [Fullan et al., 1988].

B. Complexity

From the broad perspective NET implementation implies an extension of existing policies and pedagogical approaches. The complexity of NET implementation is reflected in several policy memoranda, which were discussed in section 1.2 of this chapter. At the practical level, however, there are probably many teachers whose beliefs and practices are only partially consistent with the official policy.

Another dimension of NET complexity is evident from the variety of software teachers are expected to use. For example, Primary and Junior Division teachers would be confronted with items of "courseware" for each major element of the curriculum and additional lessonware items for each grade level [Ministry of Education, 1985]. Moreover, as discussed in Chapter II, microcomputer-based instruction can be employed in different instructional strategies - games, simulations, drill and practice, testing, lecturing, reading, tutorials and writing. Peke [1985] points out that these microcomputer uses vary in their emphasis on skills or

knowledge acquisition, and in whether they are designed for presentation of new materials or to reinforce skills/knowledge already acquired. This indicates once again the complexity of microcomputers, and suggests that teachers and students must develop skill-in-use with each software program.

C. Consensus

The prospects for successful implementation are greater when the people carrying out the implementation agree on the need, on the appropriateness of the innovation, and on the priority of the change effort relative to other local concerns [Fullan et al., 1988]. The ministry recognizes that the general movements towards microcomputer use in education reflect grass-roots interest and initiative. For example, the current non-users about 80% of the elementary/secondary teachers [Fullan et al., 1988] are not likely to become users solely on the basis of the presumed merits of the technology rather commitments could arise from a combination of parent pressure and access to direct experiences with technologies that are easy to use, and that have immediate beneficial effects on students.

There is no consensus on the kinds of innovation which might be selected. For instance, microcomputers not meeting the Functional Specifications of GEMS outnumber the GEMS machines as of 1986, 45,250 versus 14,170 [Penny, 1986]. However, the expectations are that GEMS purchases will dominate the market over the next ten years, due to their quality, the quality of OESS materials, and continued access to provincial financial subsidies for eligible hardware.

Ministry policies place emphasis on the creative learning potential of microcomputers, and on their use in all subject areas of the curriculum. Fullan et al. [1988] emphasize that there is not a clear sense at the ministry level of the degree to which teachers and students using microcomputers and software agree with those priorities. Also, the authors point out that parent support for microcomputer use in education is orientated more towards traditional computer literacy goals, e.g. in business classes for accounting , or for programming, than towards the use of the computer as a general learning tool in various subjects [Fullan et al.1988]. Furthermore, there is little evidence about the extent to which some school board priorities are or are not detracting from NET implementation at present, e.g., investing money in land property.

D. Quality/Practicality

The practicality of innovation also depends on the trade-off between the personal costs and the actual benefits of getting involved [Crandall et al., 1982, Louis and Rosenblum, 1981]. The chances for a successful change are greater when the technical certainty about the innovation is known, when there are positive student outcomes and when the innovation seems practical to the teachers attempting to change.

The ministry's decision for involvement in NET resulted from the concern about the quality of commercial hardware and software. Product quality is maximized through the development of standards for hardware/software development. Equal access is maximized by providing grants to support ministry-approved hardware and software, and by distributing sample copies of software to

all boards through the TVO Ontario Educational Software Service (OESS) [Fullan et al., 1988]. Ministry software development policies intend to insure good correspondence between the OESS material and the Ontario curriculum. A related issue is that of incompatibility of existing hardware and software in the schools. If the software is not transferable to some other branch of hardware, then one can hardly see the implementation process to be practical.

Even though positive attitudes of students to the introduction of microcomputer use in the schools have been well documented, there is still not clarity about the educational outcomes [Mitchell 1985, Solway, 1986]. There is uncertainty and a lack of research-based evidence about the actual learning outcomes of the creative use of software.

The practicality of an innovation, such as NET, is linked to the availability and access to hardware, software and money, as indicated by Fullan et al. [1988]. The Ontario Cabinet decided that a $31 million grant be given to the local boards for acquisition of hardware (GEMS) in 1987. This grew to $43 million in 1988, $53 million in 1989, and $65 million in 1990. Although there has been a steady growth in provincial allocations to subsidize GEMS purchases, the level of ministry funding is subject to annual budget deliberations. Thus, the grant for 1991 GEMS is reduced to the initial amount of $31 million as in 1987 [from to interview with Hurtubise G.in Feb 6, 1990]. This evidence suggests that there may be less difficulty in achieving the software development goals, compared with those for hardware. However, there is still a recognition that more time is needed before there will be

enough software to make it worthwhile to expect some widespread implementation across the curriculum. The lack of access to software is a problem of development as well as dissemination.

The understanding of what kind of innovation is to be implemented is essential, because innovation attributes can influence how likely real change is to occur in practice. Changes in existing educational practice, such as using new technology, have different characteristics or attributes when perceived by those attempting to develop at the design level and those attempting to use them at the local level.

3.4 Conclusion

Two anticipated changes in Ontario school education are addressed in this chapter. They are the ministry policy for NET implementation, and the specific steps for introduction and implementation of microcomputers for the study of geography. These changes are discussed from the perspective of the designer, i.e., the ministry's perspective. A relationship between those changes in Ontario education and the current study is established in terms of implementing a new aid for teaching and learning - microcomputers, or NET - into the existing practice of teaching geography in the Intermediate and Senior Divisions.

It can be concluded that ministry expectations for microcomputer use in education in general, and for geography in particular, are quite large and the challenge of these changes in education is enormous. Presently, the uncertainty about microcomputer implementation in Ontario is acknowledged. This is being resolved through hardware and software standardization and further research on the

effective use of NET. However, lack of successful classroom NET implementation models, and large diversity in hardware and software acquisitions are still acute problems. The complexity of the implementation task requires far more change in the teacher's role, classroom organization, methods, and content than most prior innovations. Finally, there is no clear measure of the new demands, personal and financial, that are being placed on individuals or the system.

There is no doubt that the scale of the Ontario Ministry of Education's effort in NET implementation and utilization must be enormous in order to succeed. Only then, will the changes, in terms of unification, standardization and cross-curriculum NET implementation, approach realisation. At the same time, there are great implementation challenges at the local level - for the school boards, administrators and teachers. The following chapter provides an analysis of microcomputer implementation at the local level.

Chapter IV

Microcomputer Implementation at the Local Level - Boards of Education

This chapter introduces discussion of the implementation process at the local level by presenting the process in each of the four boards that were studied. The methods of data acquisition are introduced and information about each board is presented, following the objectives posed in Chapter I. Those include general data about the board, elaborations on the implementation stage of the geography curriculum, computer implementation policy, hardware and software resources and management; and computer training opportunities. The summary provides a cross examination of these objectives through the boards. The information is summarized, in tabular form, in tables 4.1 to 4.4.

4.1 Methods

Three phases of data collection were used in the study: pilot test; interviews, visits and observations; and survey questionnaire. The aim of the pilot test was to confirm the relevance of the approach for the study, and to generate information to help the design of the objectives. The results of the test determined:

- which boards should be contacted;
- that there is not repetition with other studies already conducted;
- the general frame of the questions that need to be answered.

The purpose in phase three was to answer the objectives for the Local Level microcomputer policy implementation, as possed in Chapter I. Thus the questions asked gathered data about each board's computer implementation policy, microcomputer applications, and hardware and software resources and management.

The candidates for the interviews were recommended by board officials participating in the pilot test. Each of the candidates was identified as being experienced in, or informed of, the issues which are the concern of the study. The complete list of names of the interview participants from each board is presented in Appendix B.

The following section introduces the information collected during phase II. For convenience, abbreviations of the boards names are used throughout the text and the tables.

4.2 Ottawa Board of Education (OBE)

The school board is located in Ottawa and serves exclusively an urban community. As of September 30, 1989, there were 15 high schools with student enrolment about 11,255. The student population at the board has declined since the beginning of the 1980s. For example, the enrolment in September 30, 1979, was 23,056 high school students, and the enrolment in 1984 has dropped to 17,097 high school students [Lister, P., November 20 1989]. This decline is explained as follows:

- the children of the "baby boom" generation have finished high school;
- the Ottawa and Carleton Roman Catholic Separate School Boards have opened enrolment for grades 11 to 13, due to the Ministry of Education decision for fully funding the separate boards; and

- two OBE high schools were "connected" to the new (1988) francophone board of education [Lister, P., November 20 1989].

The board employs 46 full and part time high school geography teachers. For the survey, 28 were contacted, and 19 responded[1]. Three high schools (High School of Commerce, McArthur HS and Ottawa Technical HS) do not have geography teachers who teach 3 or more units, so they were not surveyed. The surveyed sample shows that long experienced (more than 10 years - 84%), male (79%) teachers are dominant; 63% of the teachers have Bachelor's (pass or honours) degree in Geography.

Geography Curriculum Development:

Curriculum implementation in the board is the responsibility of the Geography Advisor and a writing team. Priority for curriculum development is given to the Intermediate level, including Grades 7, 8 and 9, because these grades have the highest enrolment in the program. Despite this priority, the development is still in the initial stages (as of mid- April 1990), even though it is hoped that the curriculum will be ready for implementation in September 1990. For grades 10, 11, 12 and OAC, studies in geography are optional, which results in small enrolment. Thus the implementation of the curriculum for the Senior and OAC levels is anticipated in the next few years. It is the board's policy to implement 5 to 6 courses at this time, with priority given to the grades with high enrolment. This is due to the fact that more than 60 courses in Geography, History and Contemporary Studies are offered [Burgan, M., November, 1989].

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[1] The response rates obtained from the questionnaire are calculated from the total number of responses (19), unless otherwise specified.

Uncertainty about the introduction of any computerized units in the curriculum for Intermediate and Senior levels, and also for the implementation of Geographics (Part E of the Guideline) in the next several years, was expressed by the Geography Advisor. He explained that the board policy for replacement of COMMODORE 64 with IBM[2] machines creates a need for adequate software. He stressed that the issue of software/hardware compatibility is acute in the board and pointed that: "Until a solution to the problem of better access to microcomputers and hardware standardization is found, the chances of microcomputer introduction to the geography units is not great" [Geography Advisor, OBE, April 10, 1989].

General Microcomputer Implementation Policy

The board has used the microcomputer for teaching and learning purposes since 1980. The first 27 Commodore PETS were purchased on the board's initiative from its own budget. These computers were distributed depending on the "most convincing" request received from the schools. Thus, at that time, 3 computers were given to elementary schools, and 24 to secondary schools. For example, Woodroffe HS received 4 computers, where some other high schools received none. At that time the computers were used to support the Computer Study program, including courses on Computer Technology, Business and Computer Science [Vollings, G., November 1989].

Currently, the board is following a nine-year plan for computer implementation, which started in 1987. The student to computer ratio in 1989 was 15 to 1, with a planned ratio of 7 to 1 in 1995. As of 1989, the board has 857

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[2] Here IBM presents IBM compatible machines with PC-DOS/MS-DOS environments.

microcomputers, including brands such as: AMIGAs, IBM PCs (compatible) and IBM compatible, XTs, ATs, PC II, Commodore 64, Commodore PET, ICON, Macintosh and Apple [Vollings, G., November 1989]. The current trend in the board is to purchases IBM machines, which in the opinion of one of the surveyed teachers "... should help in the future as far as standard procedures are concerned."

The microcomputer implementation plan is designed independently from the board by each high school. The schools communicate their hardware requests to the board. The plan is discussed and modified according to the available budget (the final purchase is usually half of the initial proposition) at the Computer Services department. The Principal of the high school has the authority to decide which departments within the high school will obtain microcomputers. The board officials e.g. Computer Manager only approve the financial support; they do not have influence on the decision about where the microcomputers will be used or located in each school. There are three sources of financial support for hardware and software: Ministry grants (GEMS) - the board has received this grant since 1984; the board's own budget; and the high school resources [Vollings, G., November 1989].

Programs with most microcomputer time access are Business, Computer Science and Mathematics. Music, Language and Social Studies make much less frequent use of microcomputers.

Hardware and Software Resources and Management

The hardware is supervised and managed by Computer Services of the board. However, the relative autonomy of the individual departments and schools regarding

the choice of acquired hardware and software, has resulted in uneven microcomputer distribution throughout the board, within each school and department. For example: Brookfield HS has 50 ICON, ten APPLE, eight MACINTOSH and 22 IBM (compatible) computers, for 90 in total; Highland Park HS has 32 ICON, COMMODORE and COMMODORE PETs computers; Canterbury HS has 34 APPLE, IBM (compatible), AMIGA, MACINTOSH and ATARI computers. Two thirds (67%) of the participating geography teachers agreed (and 11% strongly agreed) that the school board should purchase more microcomputers, whereas only 11% disagreed.

A standard practice is to use the microcomputers in computer laboratories. Each high school has one to three laboratories serving all departments. The scheduling arrangement for the computer laboratories is revised each semester. This arrangement does not apply to the Computer Studies, which require intensive use of the laboratories due to the length of student computer time requirements for the courses.

The software is supervised and managed at the school level. In 1989, each high school received $50 per microcomputer for software purchases; this sum is reduced to $25 for 1990 purchases. The decision for software acquisition is made usually by the departmental heads in consultation with the teachers. There is also a computer resource library, with 3,200 commercial, public domain, and licensed software packages available to the teachers. For the Geography program, the library

has 35 software packages mostly for COMMODORE machines. There are 30 programs for the Intermediate Division (grades from 7 to 10) and only 9 for the Senior Division (grades 11, 12 and OAC) [Buie, B., November 1989].

The "GLOBE and MAIL" data base has been accessible to the geography students at Woodroffe HS for one year . This data base has been available since 1987-88 as a result of a pilot project. The data base has been used intensively during 1989, as suggested from the telephone bill - $1,300 [Vollings, G., November 1989]. The Computer Services manager is of the opinion that a preferable substitution for the interactive "GLOBE and MAIL" will be a collection of CD ROM diskettes. Each of these diskettes contains three months information, and a package of four can be purchased for a modest cost of $450. However, the implementation of this data base with its specialized ROM hardware has not yet been initiated.

Computer Training Opportunities

Computer training of teachers is handled by Computer Services, which provide various teacher training strategies for approximately one quarter of the teaching staff (elementary and secondary) yearly. The centre provides workshops, "dinner" meetings, or training at individual schools for teachers. The central workshops are usually offered at night, for 3 hours, from the mid- September to mid- December and from mid- January to mid- May. Teachers do not have to pay for the training, but most of the courses require their free time [Vullings, G., November 1989].

Usually 8 to 10 teachers have attended the course maximum of 25 teachers. The Computer Services current (1989) documentation on the teachers' training preferences suggests that 30% of the teachers are interested in business applications, and 10% in social sciences application [Vullings, G., November 1989]. Currently, Computer Services does not offer training to the geography teachers about specific software; rather, the program covers general computer literacy. Training for use of geography software has been offered once in the early 1980s, initiated by the then Geography Advisor.

4.3 Ottawa Roman Catholic Separate School Board (ORCSSB)

The board serves exclusively the urban population of Ottawa with three high schools. Until 1985, Grade 10 was the highest grade offered. Programs for Grades 11, 12 and OAC were offered after extensive ministry financial support began in 1986. However, the high school enrolment is characterized by a slow increase: from 1,014 students in 1979 to 2,290 in 1989 [Loren, N., November 24, 1989]. The small student population explains why there are only five geography high school teachers, all of whom responded to the survey questionnaire. All respondents have long teaching experience (more than 10 years), but, their experience in teaching geography varies in length - from short to very long periods. The fact that these teachers teach at least three more subjects besides geography, reflects the diversity in their specialties (e.g. BA Sociology, Educational Administration, Counselling and Geography).

Geography Curriculum Development:

The board curriculum developers received the new Geography Guidelines in 1988 and currently they are working on Intermediate level courses. The priority for implementation are courses for Grades 7 and 8, due to high enrolment. The implementation of the new curriculum for these grades is anticipated for September 1990; the new program for Grades 8 and 9 was implemented in September 1989. The board is in the initial process of purchasing a "Course of Study", and text books in both French and English. These study materials are developed by geography advisors in the Toronto&Hamilton area and made available for purchase by other boards. Steps towards the development of a new "World Issues" (OAC) will be taken in the spring of 1990. This will be a joint effort made by the Geography Advisors and teachers from three neighbouring boards - OBE, CBE and CRCSSB. Changes for the Physical Geography program in Grades 11 and for the Human Geography in Grade 12 are expected later on as the board is still digesting the new guideline.

Computerized units are neither implemented, nor predicted for implementation in the next two-three years. The geography advisor explains that " There is a lack of equipment (hardware), access to hardware that which exists already, and even though teachers seem interested in using microcomputers, they lack the skills and the time for training " [Geography Advisor, ORCSSB, April 11 1990]. The Advisor also stresses that the geography teachers have the responsibility

to teach at least three other subjects, which does not allow them time for any extra effort, or for learning software packages and incorporating computerized units into the already existing practice.

Microcomputer General Implementation Policy

The board initiated, subsidized and purchased the first microcomputers (5 APPLEs) in 1981, and distributed them to one elementary and to all, then four, high schools. At the high school level, the microcomputers have been used in the Business Studies and at the elementary level in all the programs.

The board has total control over the purchase and management of the hardware. There were 201 microcomputers for teaching and learning at the high school level in 1989. This includes 180 ICONs, 18 IBM (compatible) and 3 APPLE IIes. The student to microcomputer ratio is now 16 to 1 [Computer Services Manager, ORCSSB, Nov. 28, 1989]. The purchase of the hardware is subsidized from the Ministry grants for GEMS, and from the board budget. A centralized Computer Service holds the responsibility for deciding upon the installation, implementation, supervision and use of the hardware and software in each school/department. The management of the hardware and software at the school level is usually the responsibility of the Computer Science teacher, who makes requests, and who reports to Computer Services.

Current use of microcomputer is by the Technology, Computer Science, Business and Music departments. The board's future plans include the introduction of microcomputers in the Geography, History, English and Mathematics departments [Thomas, B., NOvember 1989].

Hardware and Software Resources and Management

The centralized management of the hardware and software has resulted in even patterns of distribution throughout the high schools. Thus, there are 60 ICON, 18 IBM (compatible) and 3 APPLE IIe machines in each high school. Despite these numbers, all five teachers agreed that the school board should purchase more microcomputers. The students have access to two computer laboratories equipped with ICON machines, which is the standard for the board. It is anticipated that the high schools will be equipped with one additional microcomputer laboratory, designed to serve the departments which do not have access to microcomputers now. Currently, the geography students do not have access to these laboratories. A Geography studies laboratory is planned for opening in 1990 in each high school. However, these laboratories will not be equipped with hardware for the next few years [Geography Consultant, ORCSSB, Nov. 22, 1989].

One of the Computer Services responsibilities is the management of the Software Resource Library. The library possesses 127 software packages, well organized and listed in a Microcomputer Educational Catalogue. The software is coded by media format (e.g., T - available on 3.5" disk), by grade (e.g., J - Junior high school), by content (e.g., LA - Language Arts), and by hardware compatibility. It also contains a brief description of the software aim and content. The catalogue lists 12 packages suitable to the geography studies; 11 for Senior and 4 for the Intermediate Divisions. Ten packages run on APPLE machines. The library also has available the Ontario Educational Software Services (OESS) catalogue, which lists software packages for the ICON machines. Regarding geography, there are

eight OESS packages for the Intermediate and six for the Senior Division, most of which are simulations. There are also 6 packages for the Geography Intermediate Division available in French. The Geography Advisor pointed out three main sources of information on Geography courseware that the board can make use of: Educational Research Information Catalogue (ERIC), TV Ontario and Michael Purdy's geography software guide [Geography Consultant, ORCSSB, Nov. 22, 1989].

Computer Training Opportunities

Computer literacy training for the teachers is offered at the board level. The courses are offered at no cost to the teachers. The teachers also attended two other courses at Ottawa University. One is the Computer Awareness course, lasting 6 nights, and the other is the Computer Application Course offered from September to December and from January to December. The board does not provide the teachers with financial support for the university fees. Specialized training on geography software has not been offered [Bussieres, D., Decmber 1989].

4.4 Carleton Board of Education (CBE)

This board serves an urban and suburban population in the Ottawa region. In 1988, the board had 17 high schools, two of which (Ecole Secondaire Garneau and Ecole Secondaire Louis-Riel) were joined to the newly formed francophone board. This has caused a slight decline in the enrolment for 1989. The actual enrolment of pupils is increasing at the rate of 300 to 400 annually for the last five years [Butler, E., November 16, 1989]. According to the monthly enrolment reports, the statistics for the secondary schools are as follows: 1979 - 16,721, 1984 - 17,035 and for 1989 - 15,193 students. The general trend for increases in the student enrolment is

explained by the growth of the Ottawa sub-urban areas of Kanata, Nepean, Gloucester and Richmond. The board employs 64 full- and part- time high school geography teachers, 45 of whom answered the survey questionnaire. Of the 43 respondents, 74% have more than 10 years experience in teaching high school geography, 78% are male, and the majority have Bachelor (Pass and Honours) degrees in Geography.

Geography Curriculum Development:

It is a common practice in this board that the development of the curriculum is a school - departmental, rather than board - subject advisor responsibility. The members of each geography department design their curriculum following the Ministry guidelines. As a result, it is impossible to make a general statement regarding the curriculum development and stage of implementation. The geography departments have different approaches to the design and the implementation of the curriculum. In this task, they are guided by the local conditions, such as the interest or enrolment for a course, facilities, materials etc. The Chairman of the Geography Departmental Heads is of the opinion that the implementation of computerised units, and the development of the program for Geographics is hypothetical for at least 5 to 6 years. He stressed that a course like Geographics is highly specialized, and in these terms, he expressed doubt about the adequate qualifications of the teachers [Chairman of the Geography Department Heads, CBE, Nov. 21, 1989 and April 10, 1990].

Microcomputer General Implementation Policy

The strategic plan for the last ten years has emphasized the implementation of microcomputers in Computer Science and Economics programs. For this purpose, firstly, the board purchased 225 MACINTOSHes in 1982 with its own resources. The policy has since changed, and now the board is orientated towards development of 'application labs' which are fully-equipped laboratories with hardware and software [Computer Services Manager, CBE, Nov. 8, 1989]. Computer Services at the board is determined to provide a network of MACINTOSH computers in each high school. Currently, there are approximately 30 APPLE and MACINTOSH machines at each high school, or 600 in total, with a student to microcomputer ratio 27 to 1 [Computer Services Manager, CBE, Nov. 8, 1989].

The initial decision 1982 for purchasing MACINTOSH computers was based on their price and the availability and compatibility of commercially developed software, mainly of U.S.A. production. Thus, until the Ministry's decision for support of ICON brands in 1986, the board made all purchases with its own resources. Now, the financial support for hardware comes from two sources, the board's budget and Ministry grants. The Ministry also supports with grants the purchase of software, proportionally to the purchase of hardware. At the same time, only in rare cases is a school authorized to purchase software with its own resources [Hindle, J., November 15, 1989].

Presently, microcomputers are supporting Computer Science, Economics, Business and Mathematic studies. In the near future (2 to 3 years), microcomputers will be introduced to the Music and Science departments [Cousineau, D., November 8, 1989].

Hardware and Software Resources and Management

The Program Development Department at the board has the responsibility to follow the Ministry directives for standardization of hardware and software. Thus, this department reviews the guides, makes decision and puts the theory into practice by contacting each school. The department has full control over the hardware acquisition centralized, and usually over the software acquisition also co-operative. A 'contact person' at each school has the responsibility for advising the departments within the school on microcomputer implementation and use. The 'contact person' co-operates with the Curriculum Special Assignment Teacher Section at the Computer Services Division. This division provides resource materials, both hardware and software, and recommends and evaluates software. There are no official hardware/software maintenance positions at the school level, but in some schools there are enthusiastic volunteers [Cousineau, D., November. 8, 1989].

The application labs (or computer labs) are the most common places for microcomputer use. In some cases, teachers bring a portable microcomputer into the class and use a screen display. In order to provide more free access to the labs, some schools have opened a new laboratory. For their equipment, they have used some of the already available hardware and have purchased some new. High

schools with such 'split labs' are J.S. Woodsworth SS, Merivale HS, Sir Guy Carleton SS, Sir Wilfrid Laurier HS and West Carleton SS [Consultant Computer Services, CBE, Nov. 15, 1989].

The scheduling for the laboratories is the responsibility of the Principal and the Administrative Head in each high school. In practice, the time for the application labs is almost entirely booked by the Mathematics, Business and Computer Science departments. These departments have to meet the requirements for certain hours with 'hands on experience', which leaves the other departments competing for a very limited number of hours [Curriculum Special Assignment Teacher for Sec. Ed., CBE, Nov. 15, 1989].

Computer Training Opportunities

Computer Services provides general computer literacy workshops to all teachers in the board. The workshops are offered in working hours and in teachers' free time, and they are at no cost to the teachers. Such courses are usually offered after the installation, and initial use of hardware or software. At the present, the Intermediate Team for Development of Workshops and the Special Assignment Teacher are working on a project for introducing the high school geography teachers to a variety courseware for MACINTOSH [3] and for APPLE [4]. Computer Services does not have a catalogue with listed software packages publicly available.

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[3] For example "SimCity" - Maxis/Broderbund, "HyperAtlas" - Maxis/Broderbund , "The Mining Game" - Science North, "Stratagem" - EMR, "World Data" - unknown.

[4] Foe example IIE/GS "World Geography" - DINACOMP in French and English, and "Where in the World is Carmen Sandiego" - Broderbund Software.

4.5 Carleton Roman Catholic Separate School Board (CRCSSB)

The board has five high schools in the suburban areas of Kanata, Barrhaven and Orleans. After 1984, when the Ministry fully funded the separate school boards, the enrolment grew 10% to 15% in 1985 and 1986. Currently the enrolment growth has fallen to the normal annual increase of 5%, which is projected to continue in the future. The high school enrolment for the five year intervals, starting from 1979 is 1,825; 3,359 students in 1984 and 6,967 students in 1989. The steady increase is explained by the growth of the sub-urban areas the board serves. Fourteen high school geography teachers were contacted for the survey, 12 of them responded. Half of the respondents have obtained a degree in Geography, and half have less than 4 years teaching experience in Geography.

Geography Curriculum Development:

The board has received and implemented the new geography guideline at the Senior level (Grades 11, 12 and OAC) in 1988. The OAC level curricula - World Issues, includes one unit based on the software simulation package - "Decide Your Excellency". However, a decision about software usage in the Physical Geography program (Grades 11 and 12) has not been made yet. The curriculum for the Intermediate level - Grades 7 and 8 - is in early stage of development and information on eventual incorporation of software unit(s) in the programs is not available as yet. A similar situation applies to Grade 9 curriculum development, which is explained by the fact that the geography course for this grade is compulsory. In comparison, Grade 10 curriculum development is somewhat more advanced and ready for implementation in the fall of 1990. One software based unit is

incorporated into the program, using the "Canadian Shield Railway Simulation" [Eduvision Inc.]. The computerized units are designed to maximize the use of microcomputers, and at the same time to free the teachers for other tasks.

General Microcomputer Implementation Policy:

The board made the first purchase of 100 COMMODORE machines on its own initiative in 1981. Each high school has installed 20 computers for use in their Computer Science Program [Computer Services Manager, CRCSSB, Nov. 16, 1989]. In subsequent microcomputer purchases the board has followed the standards established by the Ministry, and so has received GEMS grants [Computer Studies Co-ordinator, CRCSSB, Nov.16, 1989].

Currently, the board has 32 MACINTOSH, 46 ICON, eight IBM (compatible) and six APPLE IIE microcomputers, for 92 in total. The student to microcomputer ratio is 13 to 1. The Business and the Computer Sciences departments are the major microcomputer users. The Computer Studies Co-ordinator stressed that the board policy is to give equal opportunity for microcomputer introduction to all departments [Walker, T., April 19, 1990].

Hardware and Software Resources and Management

The supervision and management of hardware and software is centralized. The board has absolute control over purchasing, distribution and maintenance. Computer equipment is concentrated in application laboratories which are the most common place for microcomputer use. There is one ICON and one Macintosh laboratory in each high school. Occasionally, the Geography program makes use of the ICON laboratories. The scheduling arrangements of the MACINTOSH

laboratories are usually the Business department responsibility, because this department makes most use of them; the scheduling of the ICON laboratories is the high school ICON site administrator (a vice-principal responsibility). The number of hours scheduled for Geography use varies for different schools, and usually depends on the teachers' interest in using the equipment.

The software is distributed to the schools from a Resource Library. The schools have the same software, and so avoid adoption problems when teachers or students transfer to another school. Computer Services purchases and evaluates the software. If it is approved, then more copies are purchased and sent to the schools. In case a teacher requires a package which is not available at the school, the site administrator at the school will make a request to the Computer Services, or will provide finance for the purchase. Computer Services distributes a Software Bulletin to each department. The bulletin lists the available software (for ICON machines), the grade level, the subject area, gives a brief description, and the name of the training person.

There are 18 software packages available to the Geography Departments, including ten packages for Grades 7 and 8, seven for Grades 9 and 10 and nine packages for use in grades 11, 12 and OAC level. Most of them are simulations (e.g., "Canadian Shield Railway", "Eco Island"), simulation games (e.g.,"Cargo Sailor", "Unusual Countries"), one tutorial - "Bar Graph", and one utility software - "Learning Game Generator". Also, the Telechart CANSIM on-line data base is accessible to students at St. Marks HS library. The data base provides 1981-1989 data on census, immigration, transportation, trade, etc., which the students use frequently [Burridge,

J., December 13, 1989]. The system was installed in 1988 as a pilot project undertaken by the Data Dissemination Division, Statistics Canada. Statistics Canada offered "connect time" for $10 per hour, as opposed to the regular price of $70 per hour. On the board's request, the contract has received two six-month extensions [Rondeau, M., April 17, 1990].

Computer Training Opportunities

Computer literacy courses are offered on an on-going basis at the board level. They are night courses, of no cost to the teachers (with exception of a computer diskette). The board strongly encourages the teachers to take them. The application courses are offered at the board level as well. They are half-day workshops for demonstrating new software, usually in the afternoons. Those courses are less preferred by to the teacher and the board because the board has to hire a substitute teacher, and the teacher has to spend time preparing material for the substitute teacher, thus this endeavour becomes very costly [Burridge, J., December 1989].

Both types of course are offered during the school year and the summer. They are always offered after the purchase of hardware and software and their evaluation. The teachers from this board also attend courseware application courses offered by the Ministry for which tuition is the teachers' responsibility.

4.6 Cross Board Examination

General Information About the Boards (Table 4.1)

It can be concluded that the enrolment trend has been affected by urban/suburban development patterns, by the establishment of the new francophone board (the enrolment in all four boards decreased in 1988), and by the Ministry's decision for

full support of the separate boards through OAC (the enrolment in the public high schools decreased in 1985). The dominance of male, long-experienced teachers is typical for three cases (OBE, ORCSSB and CBE). Geography teachers with specialities other than Geography are more likely in the separate boards, where a teacher covers several areas of study.

Geography Curriculum Development (Table 4.2)

The curriculum development is usually centralized from the board and handled by the Geography Advisors and writing teams. An exception is the CBE, where development and implementation is decentralized, i.e. handled individually from each department. A common characteristic for all cases is that priority for development and implementation of the curriculum is given to the grades with the highest enrolment. Usually, these are the compulsory courses in grades 7, 8 and 9. The actual implementation of the new curriculum guideline varies across the four boards. The CRCSSB is the most advanced in the process, and is the only board in which computerized units are already implemented in the curriculum.

Microcomputer General Implementation Policy (Table 4.3)

Initiatives for microcomputer purchases began in the early 1980s are for all four cases. However, the number and the kind of acquired hardware varies (e.g., five APPLE microcomputers in ORCSSB compared to 225 MACINTOSH microcomputers in CBE). These initial hardware purchase have been evenly distributed to the high school (with the exception of OBE), and in most cases used in Computer Science and Business programs. Currently, there is a variety of microcomputer brands, most of which are eligible for the Ministry grants (IBM

Table 4.1 **School Board Characteristics of the Case Study Sites**

	OBE	CBE	ORCSSB	CRCSSB
Urban/ Suburban/ Rural	Urban	Urban and Suburban	Urban	Suburban
Student Enrolment in 1989 Trend	11,255 Declining	15,193 Increasing	2,290 Minimal Increase	6,967 Increasing
Total Number of HS/ Contacted HS	15 12	15 14	3 3	5 5
Teachers' Experience in High School Geography (in years)	84% > 10	74% > 10	40% > 10 40% < 10	50% < 4 5 < 40% < 9
Female % Male %	21% 79%	23% 77%	20% 80%	42% 58%
Percentage of Teacher's Speciality in Geography	63%	81%	40%	50%

Table 4.2 **Geography Curriculum Development and Implementation**

OBE	CBE	ORCSSB	CRCSSB
Intermediate Division Grades 7,8 and 9 - Early stage of development Grade 10 - Not initiated	Decentralized curriculum development and implementation - variations on school-to-school basis * Unknown comuterized units implementation	Intermediate Division Grades 7 and 8 - for implementation in 1990 Grades 9 and 10 - implemented in 1989	Intermediate Division Grades 7, 8 and 9 - early stage of development Grade 10 - for implementation in 1990 * One computerized Unit
Senior Division Grades 11 and 12 - Development not initiated		Senior Division Grades 11 and 12 - Development not initiated	Senior Division Grades 11 and 12 - impemented in 1989
OAC Level Early stage of development		OAC Level Early stage of development	OAC Level Implemented in 1989 * One computerized Unit
* Computerized units are not planned for implementation		* Computerized units are not planned for implementation	

Table 4.3 **Boards' Microcomputer Implementation Policies**

	OBE	CBE	ORCSSB	CRCSSB
Initial year of computer purchase, number and types of hardware	1980 27 COMMODORE PETs	1982 225 MACINTOSH	1981 5 APPLE	1981 100 COMMODORE
Number of computers in (1989) and student/computer ratio	857 15 to 1	600 27 to 1	201 16 to 1	460 13 to 1
Present computer types	IBM, XT, PC, COMMODORE PETs, ATARI, APPLE and MACINTOSH	MACINTOSH and APPLE	180 ICON, 18 IBM and 3 APPLE IIE	32 MACINTOSH, 46 ICON, 6 APPLE IIE and 8 PC CLONE
Present areas of application	Computer Science, Business and Mathematics	Computer Science, Economics, Business and Mathematics	Technology, Business Computer Sciences and Music	Business and Computer Science
Future areas of application	No Change	Science and Music	Geography, History, English and Mathematics	All areas

Table 4.4 **Hardware and Software Characteristics**

	OBE	CBE	ORCSSB	CRCSSB
Number of computer labs in a high school	1 to 3	1 or 2	2	2
Hardware in the computer labs	Unstandardized	MACINTOSH, APPLE, APPLE IIE	ICON	ICON MACINTOSH
Hardware and Software Management	Decentralized	Centralized - Hardware Co-operative - Software	Centralized	Centralized
Scheduling for the comp. labs	Semester	Semester and year	Semester and year	Semester
Number of geogr. courseware by division	30 for Intermediate 9 for Senior	Information not available	14 for Intermediate 10 for Senior	16 for Intermediate 9 for Senior
Number of geographic courseware by computer type	32 (COMMODORE) 6 (ICON), 3 (COMMODORE PET), 1 (APPLE), 1 (IBM) Total: 43	5 (APPLE IIE), 6 (MACINTOSH) Total: 11 - information incomplete	11 (ICON), 10 (APPLE), 2 (IBM) Total: 23	Total: 18 (ICON)

(compatible), ICON, AMIGA etc.). The student to microcomputer ratio varies from 27 to 1 (CBE) to 13 to 1 (CRCSSB), compared with 23 to 1 for Ontario secondary schools [Bill Lipischak's speech delivered to the Eastern Ontario Regional Advisory Committee meeting, April 6, 1990]. The pattern of microcomputer application is similar for all four cases, i.e., use in the Computer Science, Business and Mathematics studies is dominant. Early, future anticipated use lies within the Music and Science departments, though generalization is difficult.

Hardware and Software Resources and Management (Table 4.4)

Centralized hardware and software management is typical for the boards. The OBE is the only exception, where schools have the authority to decide about the purchases, distribution and use of hardware and software. Microcomputer laboratories are the most common organisation for microcomputer use. All high schools are equipped with one to three such laboratories. The responsibility for the laboratory scheduling arrangement varies from site administrators, vice principals, principals to Business and Computer Science heads.

These arrangements are reviewed on a semester or yearly base. Consideration to geography studies usage either does not exist, as in the ORCSSB or is minimal as with the CRCSSB. A Resource Centre e.g. CBE or Software Library , as in the OBE,CRCSSB, provides educational software to teachers are typical for all cases. Most of the available geography software is for ICON and COMMODORE machines. In all four cases, the software available for the Intermediate Division, mostly for Grades 7 and 8, outnumbers that for the Senior. Software for the OAC level is less available. On-line data bases such as Telechart

CANSIM and GLOBE and MAIL, are available in two high schools, the OBE and CRCSSB, as part of a pilot project. Even though the data bases have been intensively used by students, and the project lifetime has been extended, projects have not yet been initiated.

Computer Training Opportunities:

In all four cases, boards provide computer training by offering computer literacy courses. Such courses are offered at night, during the school year and the summer time. The boards also provide courseware application courses for geography, and for different grades and units. These courses are offered more rarely due to time and cost constraints. The courses offered at the boards and schools are at no cost to the teachers, which should be an encouraging gesture. The teachers also attend courses at the University of Ottawa and courses offered by the Ministry of education; in these cases they have to pay the tuition. The following chapter will further examine the implementation stage of microcomputers use by presenting the cross-case results of the survey data.

Chapter V

Microcomputer Implementation at the Local Level - Geography Teachers

The purpose of this chapter is to discuss how microcomputer technology is being implemented in schools by examining the role of geography teacher. This is examined by focusing on the following:

- background information about the microcomputer experience of teachers;
- frequency of microcomputer use and accessibility to microcomputers by teachers;
- complexity of current and anticipated microcomputer use;
- teachers' opinions about microcomputers generally and in relation to geography; and
- teachers' training and training preferences.

5.1 Methods

Initial data collection was done by survey questionnaires distributed to geography teachers. The objective of this approach was to gain first-hand information about the position of geography teachers in relation to microcomputers. The questionnaire was designed according to the study objectives posed in Chapter I. The Geography Advisors at each board provided the names of all high school geography teachers. The survey samples were selected so that only full-time geography teachers teaching 3 or more units a day, participated. Part-time geography teachers were not surveyed because it was felt that the time limitation would weaken teachers' interests in using

microcomputers in the program. Exceptions to this rule were made when the geography advisors recommended teachers who have been on a full-time term position in 1989.

The original questionnaire and letter of introduction were pre-tested on about twenty graduate students and professors in the Department of Geography at Carleton University, and geography advisors at the boards. The Research and Development Departments at each board were approached with a letter asking for permission to conduct the survey, providing information about the study and a copy of the revised survey instrument (Appendix A)[1]. Permission and advice on changes was received from each board, and some editing and finalization of the questionnaire was made.

The questionnaire consisted of items of personal characteristics, such as sex, years of experience for different grade levels, education degree, years of computer experience and computer ownership. It also contained measures of computer related variables, including:

- teachers' perceptions of the value of computers in education, and their value in geography (on the scale of five, from strongly agree to strongly disagree);
- frequency of microcomputer usage and accessibility (Yes or No);
- complexity of microcomputer usage now and in the future (total of 12 options); and
- teachers' training and training preferences (total of 7 options).

In total, the questionnaires were mailed to 93 geography teachers and 79 were returned. The figures on each board are presented in Table 5.1. The names of

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[1] In the case of CBE, an application form and other documents were required.

Table 5.1 Survey Data

Boards	Questionnaires Mailed	Questionnaires Returned	Return Rate
OBE	28	19	68%
CBE	45	43	96%
ORCSSB	5	5	100%
CRCSSB	14	12	86%

the teachers contacted in the survey are listed by school and by school board in Appendix B. The anonymity of the participants was ensured by coding each questionnaire with the corresponding code for the board. This made possible the identification of the boards, but not that of the particular school or teacher.

The following section examines each variable on the basis of the data obtained from each board. For convenience, abbreviations of the boards' names are used throughout the text and the tables.

5.2 Attitude About Microcomputers

Teachers have the greatest influence on how the computer is used in the classroom, and consequently, on how it will be perceived by the students [Manarino-Lettett, 1985]. Berg [1983] indicates that teachers' attitudes are viewed as the most misunderstood resistance factor in the adoption and implementation process. Thus, teacher attitude is an important factor influencing microcomputer implementation.

The analysis of the survey data indicates that there is a positive attitude towards microcomputers among the geography teachers who responded (Figure 5.1). The teachers' attitude towards general microcomputer use indicates that 80% to 90% of the teachers from the four boards perceive microcomputers as a useful

instructional tools, and are of the opinion that geography teachers should be computer literate. This is illustrated in the following teachers' comments:

> "Computers are an excellent tool to enhance teaching and learning styles" [microcomputer user from CBE];
>
> "Microcomputers help to put into immediate practice, or reinforce ideas introduced in the classroom" [user-beginner from OBE],
>
> "The microcomputer is a very useful piece of technology that we must all take advantage of in the modern world" [user from OBE] and
>
> "I think every teacher should be computer literate" [user from CBE].

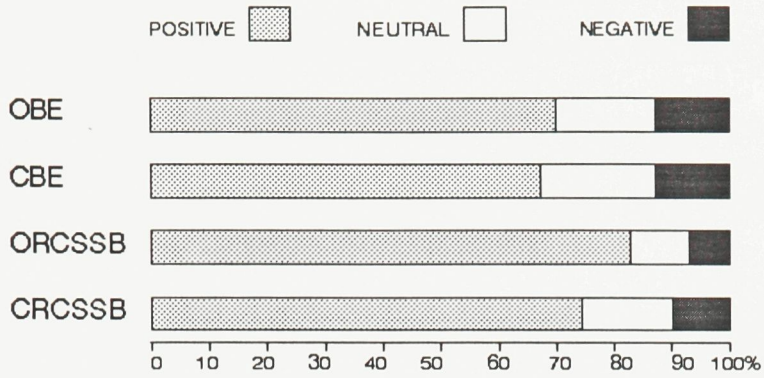
Even though in the minority, there were negative opinions about the use of microcomputers, such as:

> "... computers have been mistakenly thought of as the panacea for students who are bored or not doing well in their assignments. We are already competing with a multitude of visual media outside the school - let us not add another one" [user from CBE] and
>
> "Students can become just as bored using a computer as they can if maps or films are overused" [user from CBE].

However, in all four cases, there is a diversity of opinion on whether microcomputers are frustrating tools and whether they can isolate students. From the OBE teachers, 29% agrees, 24% disagrees and 41% are undecided whether microcomputers are frustrating instructional tools. A similar pattern also characterizes the other three boards. Some of the teachers comments regarding these issues were:

> "Microcomputers will isolate students from each other depending on how they are used." [user from CBE];
>
> "Students are isolated from each other when using microcomputers. School should be more than a place to go to collect information" [user from CRCSSB].

Figure 5.1 Teachers' Attitudes Towards Microcomputers



Teachers find frustrating the following factors:

> "... when the equipment breaks down or the software malfunctions, an extra level of stress is placed on the teacher." [non-user from CBE];
>
> "Any programs I have asked the board office to translate for use on MACINTOSH have been unsuccessful. I find this frustrating!!!" [user from CBE]; and
> "All my software programs are for COMMODORE PET computers, which are frequently breaking down and the technicians are reluctant to repair" [user from OBE].

Microcomputer use in geography is perceived as being valuable in all boards. Most teachers, ranging from 70% in OBE to 100% in ORCSSB, are of the opinion that the use of microcomputers is valuable and that it can increase student interest in geography. The results regarding the appropriateness of geography for the use of microcomputers as a spatial concept tutor are similar. This is supported by the following teachers' comments:

> "I feel that computers are an excellent and worthwhile vehicle for learning Geography" [user from CRCSSB],
>
> "Computers are necessary as a supplement to, and guide for the application of geographic principles to the present day situation simulation, regarding the world and the Canadian current issues" [user from OBE] and
>
> "I agree entirely that computers could enhance the students interest for, and comprehension of Geography" [user from OBE].

At the same time, there were some more reserved comments, e.g.:

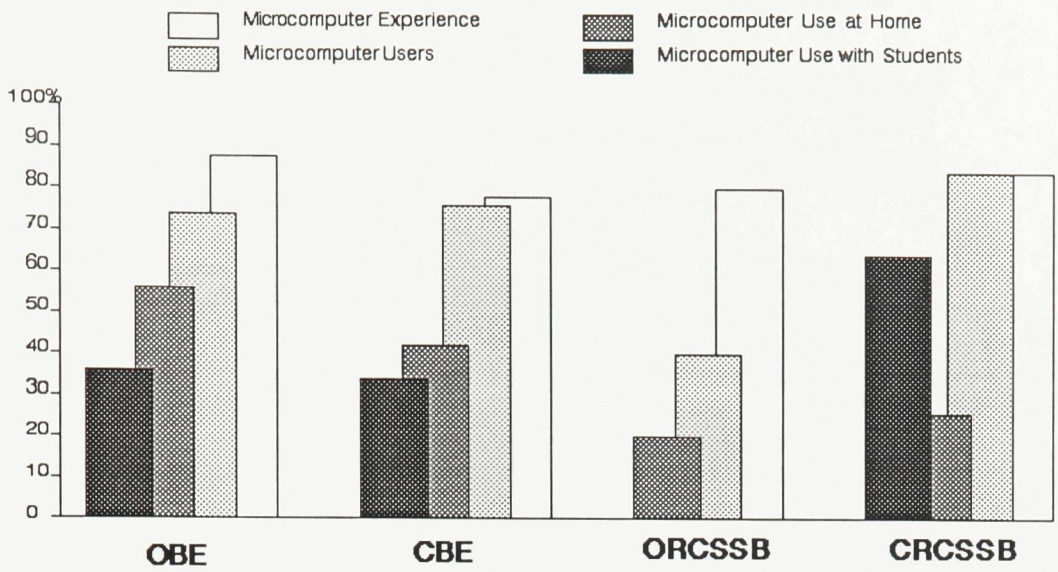
> "I think microcomputers are helpful for teaching some aspects of a geography course. However, I hope they do not become so popular that educators widely accept many programs as a substitute for the classroom teacher" [user from CRCSSB].

The teachers had different opinions about the statement that microcomputers are of little help in achieving the objectives of high school geography, i.e., 78% in OBE, 50% in CBE, 20% in ORCSSB, and 42% in CRCSSB. Very few however were undecided about it, i.e., 11% in OBE, 20% in CBE, 20% in ORCSSB and 8% in CRCSSB.

5.3 Teachers' Microcomputer Experience and Use

Analysis indicates similar patterns of geography teachers' microcomputer experience in all four boards. For example 89% in OBE, 79% in CBE, 80% in ORCSSB and 83% in CRCSSB teachers have gained some knowledge about microcomputer use by practice, trial or observation (Figure 5.2). The highest rate of microcomputer experience was amongst the OBE participants - 89%, and the lowest rate was in the CBE - 79%. The average years of microcomputer experience ranged from four and a half years for OBE teachers, to three years for the CRCSSB teachers. There are also some extreme situations as in the instance of OBE, one teacher has fifteen-, and another two teachers have ten years of microcomputer experience. Another example is in CBE, where several teachers report to having a few weeks to a half-year of computer experience only. The microcomputer is used by most teachers who had microcomputer experience; ORCSSB is the only exception where out of four teachers having microcomputer experience, only one is actually using the microcomputer in practice (Figure 5.2).

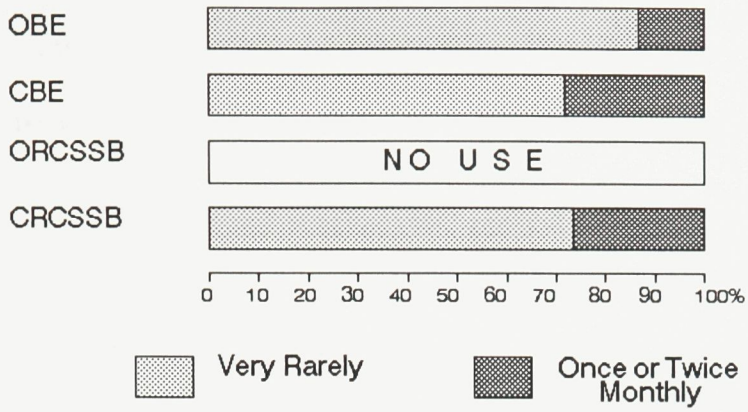
Figure 5.2 Teachers' Microcomputer Experience and Use



The participants have exposure to the microcomputer in the home environment. Around one-half of the OBE and CBE teachers, and around one-quarter of the ORCSSB and CRCSSB teachers have such access. The average years of home microcomputer exposure is different for each board, and it ranges from 5.75 to 2.4 years in OBE to two and two-fifths years in CBE. Analysis indicates that usually the long-term (four or more years) microcomputer users have access to a home microcomputer, e.g., seven out of ten OBE teachers, eight out of eighteen CBE teachers and one of one ORCSSB teacher.

It should be noted that in the case of ORCSSB, one respondent (20% of the total respondents) indicates microcomputer use at home for five years, and in the case of CRCSSB - two teachers (16%) indicate such use for three and four years. In the case of CRCSSB, two individuals indicated that they borrow microcomputers for home use from the microcomputer centre. This procedure is also practised at the CBE as indicated by two participants.

Figure 5.3 Frequency of Microcomputer Use in Geography Instruction



The respondents usually use the same brands of hardware at home, as those acquired in their board of education. At CBE for example, ten out of sixteen home microcomputer users have APPLE environment machines, which are used at this board (discussed in Chapter IV, Section 4). In the case of the OBE, the home users are divided between the APPLE and MS-DOS environments, which could be connected to the diversity of microcomputer brands in this board (discussed in Chapter IV, Section 2). It is interesting to note that some teachers acquired microcomputers to correspond to the computer brand their children use at school. For instance, two teachers from the CBE indicate they have access to IBM machines at home, which are mainly used by their children who attend schools in the OBE. Another example is a teacher from ORCSSB, stating: "I have my own APPLE IIE purchased because my kids went to Carleton schools".

Microcomputer use for geography instruction varies from board to board (Figure 5.2). Three different patterns of use have become apparent:

- *No Use* - is typical for the ORCSSB, i.e. none of the participants in the survey has indicated microcomputer use in the instructional program;

- *Some Use* - typical for OBE and CBE, where over a third (OBE - 39% or N=7 and CBE - 36% or N=15) of the respondents indicated microcomputer use in the instructional program; and

- *Moderate Use* - in CRCSSB, where 67% (N=8)of the respondents indicated microcomputer use in the instructional program.

Although the pattern of microcomputer use differs in the four boards, analysis indicates that the frequency of microcomputer use is fairly similar for the three boards (Figure 5.3). "Very rarely" and "once or twice monthly" microcomputer instructional use is reported by all of the teachers. From these, more than one third from the CBE and the CRCSSB and four-fifths from OBE replied with "very rarely". The other options in the questionnaire regarding the frequency of use, such as "once a week", "two or three time a week", and "daily" were not considered as applicable.

5.4 Teachers' Complexity of Microcomputer Application

Analysis indicate uniformity of the current microcomputer applications (Figure 5.4). Applications include teachers' personal as well as classroom microcomputer use. Word processing is the most common use of the microcomputer with 74% (OBE) to 62% (CBE) of teachers using this application[2]. The use of spread sheets (CRCSSB - 67% of the teachers, OBE - 26% of the teachers) and test score analysis (CRCSSB - 34% of the teachers, CBE - 27% of the teachers) are the second and third most used application. These are followed by interest in data base management and C.A.I., i.e., between 15% and 25% of the teachers from each board.

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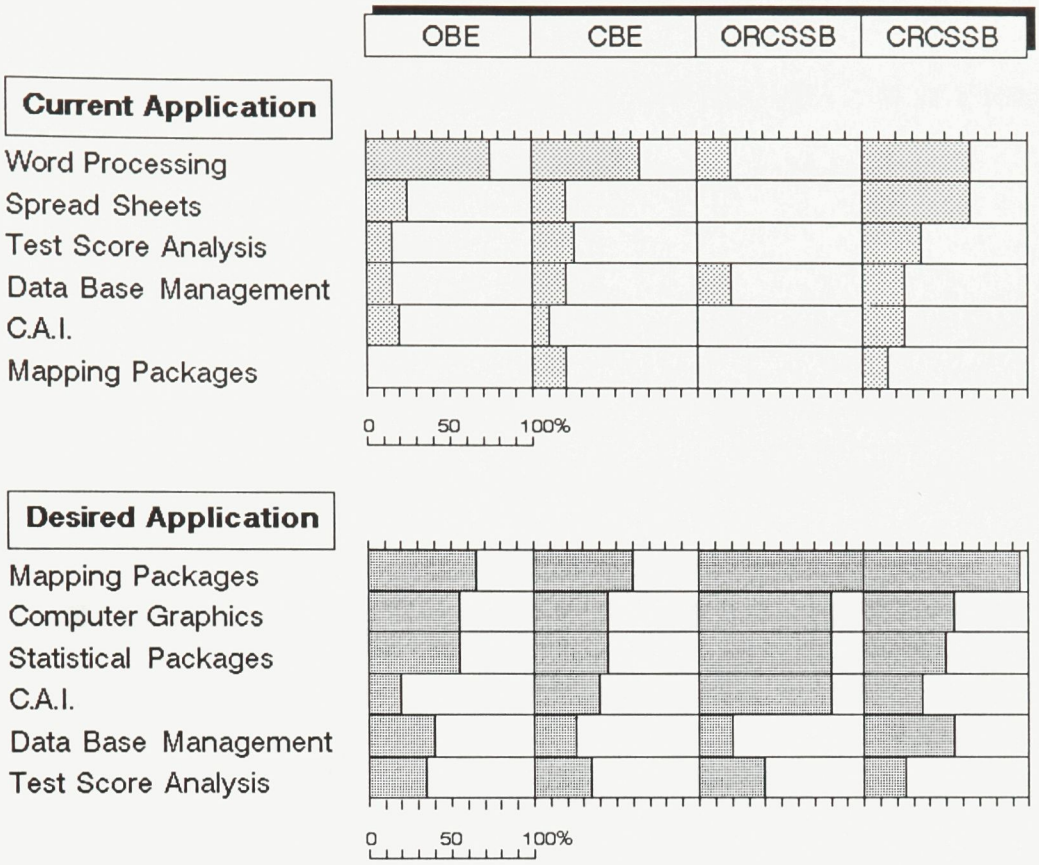
[2] Participants from ORCSSB are not considered in the across-the-boards discussion due to fact that three from five participants reported no microcomputer use. Therefore, using a percentage to describe the other two participants would distort the information.

Figure 5.4 **Teachers' Application of Microcomputers**



Other applications, such as desktop publishing, tele-referencing and computer graphics are rarely used, i.e. usually by 5% to 15% of the microcomputer users. In the ORCSSB, one teacher uses word processing and data base management.

The applications indicated as desirable in future, are different from those currently mostly used (Figure 5.4). The teachers are mostly interested in using mapping packages in the future. For example, all teachers from the ORCSSB indicated a preference for this application, as well as 92% of the teachers from the CRCSSB, and around one-third of the teachers from the OBE (68%) and CBE (59%). Computer Graphics and Statistical Packages are indicated as being of interest as well, e.g. approximately one-half of the teachers from OBE, CBE and CRCSSB are interested in these applications. Tele-referencing seems to be the least

popular application among the teachers, e.g., 3% in CBE, 11% in OBE and 17% in CRCSSB indicate interest in using tele-referencing in the future.

5.5 Accessibility to Hardware

Access to instructional tools is of critical importance if these are to be implemented in every day teaching-learning practice. The general hardware and software organization and management in each board was discussed in Chapter IV. This section emphasises access to microcomputers specifically for use in the geography programs (Figure 5.5).

Microcomputers for instructional purposes are generally accessible in microcomputer labs. This is a characteristic for all four cases, but to different extent. For instance, all teachers from the CRCSSB report to have access to a computer lab, compared to 72% from the OBE, and 43% from the CBE. In the case of the ORCSSB, even though two of five teachers stated they have access, the interview data suggest that the arrangements for microcomputer laboratory use for geography are highly unlikely, and even if teachers succeed in making an arrangement, this will still be only an exception to the regular practice [from interviews with geography advisor and microcomputer services manager].

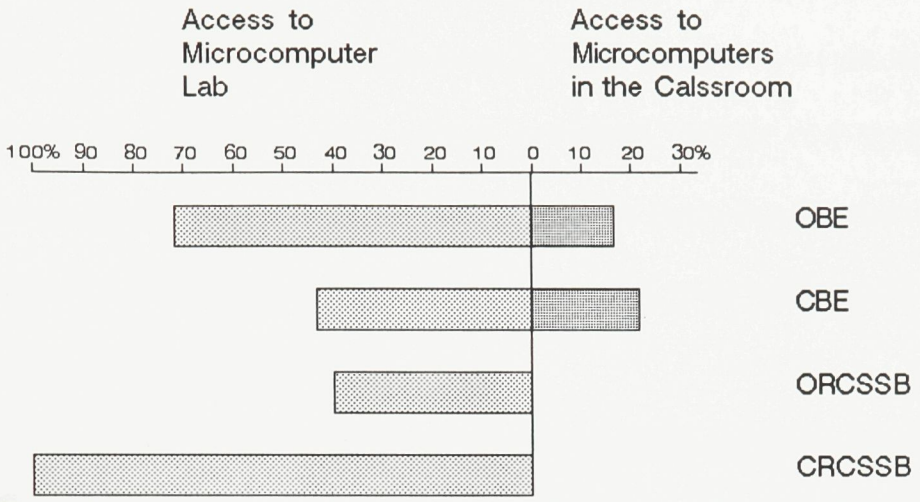
The scheduling of the computer labs is perceived by most participants to be arranged with difficulty. About one-third of the participants considered such arrangements as difficult to make, i.e. 38% (OBE), 40% (CBE) and 35% (CRCSSB). An exception is ORCSSb with 60% of the teachers feeling difficulty in scheduling computer labs. Accessibility to computer labs is illustrated in the following statements, providing a guide to the situation as perceived by some of the participating teachers:

> "... in our new school, no lab is available directly for geography use, and therefore it is more difficult to see how to integrate more software into the curriculum." [user from CBE];
>
> "The computers in our school are used by regularly- scheduled classes all day. It is next to impossible to flip-flop classes, so that our geography classes use the computers" [user from CRCSSB]
>
> "The machines are available, but conflicts over who gets to use them do arise, i.e., the computer science classes are scheduled at the same time as the geography classes" [non-user from CBE].

However, not all teachers having access to computer labs take advantage of the possibility of use. For example, one-forth of CRCSSB teachers, one-third of CBE teachers and one-third of OBE teachers, who have access to a microcomputer lab do not make use of it. Some factors effecting the use of microcomputer labs are related to time constraints, teachers' attitudes about the usefulness of microcomputers for their geography program, teachers' microcomputer experience, and the availability of suitable software. The following citations illustrate the variations in teachers' non-lab-users comments about the use of microcomputer laboratories.

> "I need time to adapt computer software programs to specific lessons and concepts for various grades and levels" [teacher from CBE];
>
> "I find the curriculum (Grade 9) overloaded, therefore I do not have enough time to include computer assignments" [teacher from OBE];
>
> "We have ICONs in our computer lab, but they are not available until after school. With so many of my students having after-school commitments (work, sport teams, etc.) it is impossible to get a class to use them" [teacher from ORCSSB];
>
> "Teachers will not tend to arrange for the use of computer rooms located in another area of the school unless they have a strong commitment to them" [teacher from CBE] and

Figure 5.5 **Teachers' Accessability to Hardware**



"The classes are too large for anything meaningful, the academic material is not sophisticated enough to warrant a lot of expensive computers and programs, and students get more valued personal instruction from the teacher" [teacher from CBE].

Another, less likely alternative to microcomputer access, is the installation of microcomputer unit(s) in the geography classroom. Only about two-fifths of the responding teachers from each of the OBE and CBE indicated such possibility. No one from the other two boards indicated that they had access to microcomputers directly in the geography classroom. A teacher from the CRCSSB stressed that:

> "In the secondary schools, the geography department should have a minimum of one computer for departmental use, as well as access to computer labs", and another remark from a CBE user:
>
> "In order to be viable in a class with 30 students, at least five computers must be available".

Teachers' resentment regarding lack of access to microcomputers is illustrated in the following remarks:

> "We do not have access to computers in the classroom. As a result, their use, although desirable, is impossible. School boards do not appear to be concerned about the use of computers in geography" [user from CBE], and
>
> "In order to be able to include microcomputer assignments in the already overloaded curriculum, I need the computer directly in my classroom. I know I am dreaming!" [user from OBE].

However, not all the teachers accessing microcomputers in the classroom make use of them. For example, in the OBE the teacher is a non-user and thus he does not use the computer lab. Other examples include one found in the CBE where two teachers indicate lack of microcomputer experience, and another teacher indicates lack of software, as impediments to using geography room computers.

5.6 Accessibility to Software

Lack of accessible and appropriate software is a common factor affecting a teacher's decisions not only in using a microcomputer lab, but for use of the microcomputers in general. This is an acute issue in the OBE, where teachers indicated that there is no available software for Grade 9. Teachers stated that:

> "More programs should be available for the class use especially at the Intermediate level (Grade 9)" and
>
> "Presently, I have no software available for use specifically for geography at the Grade 9 level. Most of my classes are Grade 9."

Another problem at this board appears to be the lack of software for IBM computers, expressed by the teachers as following:

> "I would like to use computers, but it is difficult to find out what programs are available. I have phoned IBM in Ottawa but there does not seem to be much." and
>
> "There is little adequate software available and usable on the IBM PC which are the computers available in this school."

Access to compatible software is also a problem in the CBE, where in addition, lack of access to hardware is apparent. These issues come forward from several comments from the CBE teachers:

> "Since most schools are replacing APPLEs with MACINTOSH machines, it would be useful to have more software compatible with MACINTOSH.";

> "It would help if we knew of geography software for the MACINTOSH.";
>
> "Most decent geography programs are for APPLE, but we have MACINTOSH.";
>
> "I am not aware of software for MACINTOSH, that has geographic applications." and
>
> "It is difficult to find good software programs related to our teaching, and compatible to our computers."

A problem of available software is also indicated by an ORCSSB teacher-user, who states that

> "... suitable software for ICON machines is not available, or if it is, I have not got it".

It is interesting to note that this teacher expects to obtain the software from someone, rather than to look for it independently. According to the interview data, discussed in Chapter IV, the ORCSSB has a sufficient amount of software for all grades, which could lead to the conclusion that the teacher is not interested or motivated in using microcomputers, or the distribution procedure is flawed.

Concern about the suitability of the software packages is expressed by a CRCSSB teacher as follows:

> "Graphics and choropleth mapping packages for geography are very poor. The available software does not keep up with the new Ministry guidelines. The software for Senior students is in many cases poor quality".

The issue of software availability can be summarized with the responses from an OBE teacher:

> "There is a serious lack of "good" programs for geography in Secondary schools".

The software packages used for teaching geography include simulations, simulation

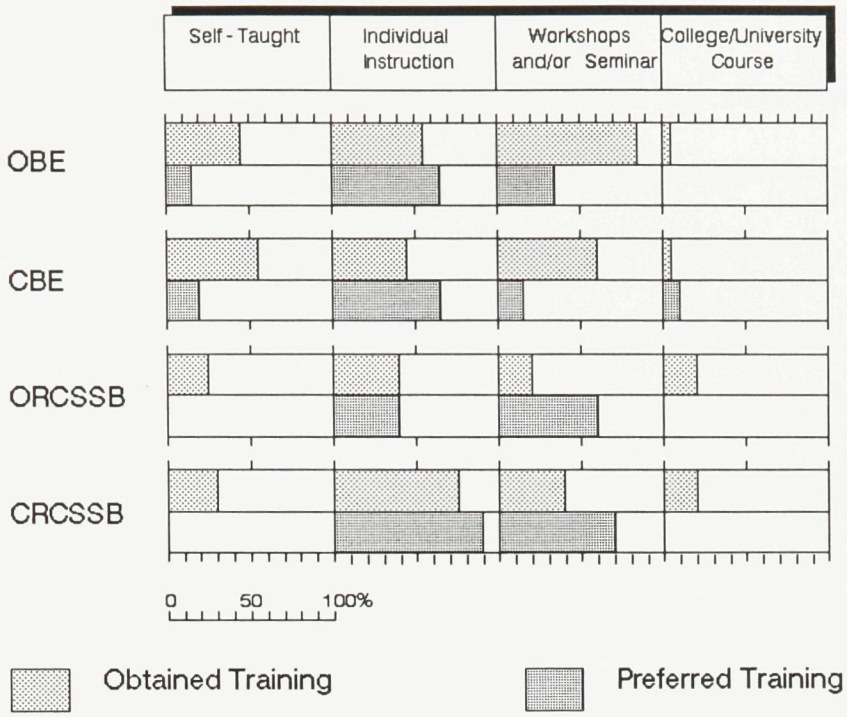
games, mapping and graphic packages, and geographic data bases. This selection of geographic software is similar in three boards, as indicated by the respondents (ORCSSB participating teachers are an exception). The educational software varies according to the hardware available to the teachers. In this manner, the CRCSSB participants usually use courseware compatible with the ICON machines, the CBE participants - courseware compatible with APPLE, APPLE IIE and MACINTOSH machines, and the OBE participants - courseware compatible with the COMMODORE and COMMODORE PET machines. The geography courseware denoted by the participants as commonly used, including the producer, system configuration, grade level, and the type of software are listed under the heading "Geographic Courseware" in Appendix C.

5.7 Teachers' Microcomputer Training

Computer training is considered an essential factor determining microcomputer use [Austin 1988, McCoy and Haggard 1989, Bean 1988, Makau 1989]. The ways geography teachers obtained, and attempt to obtain, microcomputer training are examined here (Figure 5.6). Approximately ten percent of the respondents from each board have not received such training (Figure 5.4). An exception to this is the ORCSSB, where three of five respondents have not.

Workshops and/or seminars are dominant ways of training for the majority of the respondents from the OBE - 84%, and the CBE - 68%. The respondents from the other two boards have obtained microcomputer training through individual instruction, e.g., 75% in CRCSSB, and the two teachers from ORCSSB.

Figure 5.6 Training and Training Preferences



Other, also popular ways of training, are individual instruction and self-taught, indicated by one-half of the respondents in each of the OBE (53% and 48%) and CBE (47% and 53%). Pre- or in-service training, college/university courses, and self-taught, were the responses indicated by one-fifth of the CRCSSB, and one teacher from the ORCSSB. College/university courses were indicated by only five percent from the OBE and CBE respondents.

The preferred ways for obtaining training differ from the training geography teachers have experienced. In that manner, one-to-one instruction was indicated as most desirable by the majority teachers from OBE the (68%), CBE (68%) and CRCSSB (92%). However, in the ORCSSB four of five teachers (80%) responded that programmed learning right at the computer is the most preferred way for training. Workshops and seminars were also indicated as desirable by about one-third of the ORCSSB (60%) and CRCSSB (67%) teachers, and two-fifths of the OBE (38%) teachers. Self-taught training was indicated by only about one-fifth of

the OBE (16%) and CBE (18%) teachers as desirable: the teachers from the other boards did not consider this option. College-training appears to be even less popular - only 8% of the CBE chose this option, and none in the other boards.

The popularity of the training methods depends on the teachers' positive or negative experience during the training. The negative attitude to college/university courses, which had only minimal use as an existing training method, and low preference (Figure 5.6), may result from the experiences related below:

> "I would like to get some instruction on how to use computers. Unfortunately, the one course I took at Ottawa University was terrible." [user from CBE] and

> "I got turned off or scared after my CAI course at Ottawa University. It was made much too complicated, i.e., it taught how to write in Basic, rather than how to use a computer" [non-user from ORCSSB].

Obviously this negative experience determines the future preferences for training of these teachers, e.g., in the questionnaire, both teachers choose other options for future training. This can explain why the college courses are not popular among the geography teachers. However, a need for training is apparent, as expressed in the CBE teacher comment:

> "We need someone to show us the applications of the software packages to our course".

5.8 Cross Board Examination

This chapter concentrated on the stage-of-implementation at the local-teacher level. Here are presented several final comments from the discussion.

Teachers' attitudes towards microcomputers and their use in geography are perceived as positive in all four boards. The respondent teachers also agree that microcomputers can increase student interest in geography, and that computer

literacy is important for the geography teacher in all four boards. The statements concerning microcomputers as frustrating tools, and the microcomputer's contribution to student isolation, generated widely different attitudes among the teachers from all four boards.

The vast majority of teachers have experience with microcomputers, with an average of almost four years duration. This is typical for all four boards. The number of teachers having access to a microcomputer at home varies from one-half (OBE and CBE) to one quarter (ORCSSB and CRCSSB). There is a positive correlation between the years of microcomputer experience and the access to a home microcomputer. In other words, there is a tendency that long-term microcomputer users tend to purchase, or arrange access to microcomputers, more than the teachers with brief, or without, microcomputer experience. Borrowing microcomputers from the school or the microcomputer centre at the board for teachers' home use, even though not common, is an existing practice in three of the boards. Teacher who are also microcomputer owners usually acquire the same brand machine as they have access to in their school. The reverse situation seems to be an unwanted circumstance, as pointed out by a OBE user:

> "A problem is the fact that my computer at home ... is not compatible with the ICON, due to different operating systems. This means that I would have to stay at school very often to organize the work, etc.".

The actual use of microcomputers in the classroom varies in all four boards. This extends from two-thirds of participants using microcomputers in the classroom to none. However, in those three boards where there is microcomputer use, the frequency is very uniform, i.e. at most once or twice monthly. The teachers use

microcomputers for various applications, but word processing is indicated as the one mostly used, in all four boards. This application is followed by spread sheets and test score analysis. The applications which geography teachers use mostly are not what they desire to use in the future. In that manner, mapping packages are the most desirable application followed by computer graphics and statistical packages. This is characteristic for all boards.

The access to microcomputer in computer labs varies drastically among the boards, i.e., from 100% in CRCSSB, 75% in OBE, 40% in CBE to 0% ORCSSB. Despite these differences, the scheduling for the labs is perceived as difficult by microcomputer users and non users, in all boards. Even though desirable, access to microcomputers directly in the classroom is minimal, i.e.,less than one-fifth in the OBE and CBE, and none in the other two boards. However, having microcomputer access in the classroom is not a guarantee that the teacher will make use of it, which is found in three boards. In the fourth board, teachers did not have any access. Indicated causes for this situation are the lack of microcomputer experience, interest in using the microcomputer; time to search for software programs and lesson preparation; applicable curriculum, and computer compatible software.

Computer training is essential, especially for teaching geography application software programs. Receiving individual instruction, workshops/seminars, and learning right at the computer are the most desirable ways of training. College/university courses, and self-taught courses are the least popular way for obtaining computer training. The analysis indicated that these characteristics regarding the teachers' training and training preferences are typical in all boards.

Chapter VI

Microcomputer Implementation in Teaching-Learning Geography - Some Conclusions

The patterns of microcomputer implementation in the geography program at four school boards were discussed in the preceding chapters. The results are presented according to the objectives posed in the beginning of the study. In order to draw some conclusions about the implementation process, this chapter summarizes those findings in three ways. First, the factors effecting microcomputer implementation in geography in the four boards of education are presented. Second, the findings are interpreted in the light of existing theories of school change implementation. And third, the findings are summarized as a set of practical recommendations to policy designers and to school board administrators and teachers.

6.1 Summary of Findings

The following section summarizes the study findings.

6.1.1 At the Design Level

The current focus of the microcomputer (as part of NET) implementation policy in Ontario is to assist teachers in learning to use microcomputers and educational software with students in the classroom. The integration of this use into the

teaching-learning process of all subject areas and all grade levels of the curriculum is emphasized. The use of microcomputer as a tool to benefit to the creative learning is promoted.

To reduce frustration and difficulty during the implementation of the hardware and educational software, their characteristics should be taken into consideration. It is necessary to gain a clear understanding of what to do and change in order to put them into practice. Also, the complexity of these new educational technology should be reduced, in order to avoid the risk of partial, superficial use or even giving up. In the case when the replication of microcomputer implementation and utilization is the main goal, it is necessary to give a high degree of priority to the production of procedural specifications, once the innovation is debugged.

6.1.2 At the Local Level

General Policy for Microcomputer Implementation:

Microcomputer applications are dominant in the Computer Science, Business and Mathematics studies. Microcomputers in Geography are currently used in three of the four boards surveyed, i.e., OBE, CBE and CRCSSB. Board policies for anticipated microcomputer use lie within different subjects for each of the boards (Table 4.3).

Frequency of Use:

The frequency of microcomputer use by students in geography is low, ranging from several times during a semester to once or twice a month.

Complexity of Applications:

The common educational software used with student includes simulations, simulation games, mapping and graphic packages, and geographic data bases. Geography teachers use microcomputers most often for word processing, test score analysis and spread sheets.

Teachers' Attitudes:

Geography teachers have a favourable attitude towards the use of microcomputers for teaching-learning geography.

Microcomputer Training:

Geography teachers have received microcomputer training, usually at an introductory level by attending workshops and seminars. There is a strong demand for more individualized training specifically in geographic software application.

Availability of Hardware:

The availability of hardware to geography classes varies in all four boards, and ranges from available, and partially available, to not available at all. Such diversity is explained with Boards' general policy for microcomputer curriculum applications, in the cases where a centralized approach to management is applied, and school climate where a decentralized approach to taken. From the teachers' perspective, changes in the brands of hardware installed for teaching purposes are related to problems of 'home - work' computer compatibility and software translation and acquisition. Those changes were found to be in progress in two of four boards, i.e., OBE and CBE.

Availability of Software:

Geographic software from the Boards' computer center is limited by number, grade level, type, and hardware compatibility. Teacher-enthusiasts usually obtain courseware on their own initiatives. Other teachers experience a great deal of frustration in dealing with those problems. Those include obtaining curriculum applicable and hardware compatible software, software translation, and sufficient number of software for classroom use.

General Findings About Microcomputers:

The general findings with regard to the microcomputer in the four boards were that:

- Microcomputers were not dominated by a single brand of hardware (Table 4.4);
- Microcomputers were used for a variety of curriculum topics on an unequal basis (Table 4.3);
- There are at least two sources of funds for microcomputer acquisition, i.e., Ministry grants and Boards' own resources;and
- There is diversity in the nature of microcomputers' supervision, with both centralized (top-down) and decentralized (bottom-up) types of systems prevailing (Table 4.4).

Based on the analysis from the four boards' investigated the evidence suggests that it is premature to conclude that microcomputers have been effectively implemented in the regular teaching-learning practice in high school geography classes. There is a diversity in the use of microcomputers in geography between the boards and within the schools in each board, determined by the approach of microcomputer introduction to the geography curriculum guidelines.

Re-examination of findings for the four boards suggests that the factors affecting this implementation process can be characterized as a need for support for

geography teachers in three spheres: time, computer access and courseware.

TIME

Teachers need time: to become computer literate; to investigate microcomputer capabilities for teaching- learning geography, individualization of instruction and interaction with students; to search for appropriate software; to investigate the suitability of software; to incorporate courseware into the lesson unit; and to implement the new workable computerized lesson units.

COMPUTER ACCESS

Teachers' need for access to hardware is fundamental and critical. The geography classes are very limited to access to hardware located in computer labs. The lack of access directly in the geography class room is even more emphasized. This situation occurs as a result of administrative arrangements. Implementation of computerized units into the geography curriculum without freedom in accessing the hardware is ambiguous. It is of paramount important that there are regularly scheduled geography classes in the computer labs.

COURSEWARE

Integrating microcomputers into the regular teaching practice requires not only access to hardware, but courseware suitable to the curriculum of each geography based course as well. It is also essential that the courseware is pretested beforehand, is compatible with the available hardware and includes user guides with methods for adapting lessons to the computer lab.

Beyond these needs, specific to geography, the factors found to be important to the implementation process in the four boards are:

The importance of the centralized approach to software/hardware management and curriculum development, resulting in closer co-operation between administrator and teachers.

The importance of a microcomputer co-ordinator, (preferably a person other than a teacher), responsible for the microcomputer management in schools.

> The importance of formal training programs (workshops and seminars) and more technical instruction on a one-to-one basis, for teachers to use microcomputers.

Other implementation factors may be added to the above list, by inference. First, this study found that there is no a great resistance to the use of microcomputers, so it can not be reported that the reluctance of teachers towards technology has hampered this innovations. The same phenomenon was also reported by Blachke [1983] and Yin and White [1984]. Second, the use of microcomputer technology was found not to be influenced by the teachers' perception of microcomputers, which was also find by McCoy and Hagerd [1989], and by gender also found by, Trollip and Alessi [1988]. However, this study found that the use of microcomputers was not influenced by the teachers' length of teaching experience, as opposed to the McCoy and Haggard's [1988] study where they found that computers are used more by experienced teachers. This can be explained by the fact that 80% of the participating teachers in this study have more than ten years of teaching experience. Third, the shortcoming in courseware, courseware/hardware compatibility and courseware applicability to curriculum were found to be important factors influencing the implementation process, also found in common with Fullan et al. [1988]; Plomp and Akker [1988] and Makau [1989].

Finally, two dominant features of the previous reports were not found by this case study primarily because this study was not designed to investigate these topics. This was the common finding that microcomputer use is generally facilitated by "teacher-enthusiast" and "student-expert" [e.g., Roberts, 1982, Sheingold et al., 1983

and Olson and Eaton, 1986]. This study did not examine the characteristics of individual users, and therefore cannot comment on the importance of this feature in relation to the implementation process.

6.2 Practical Guidelines for Effective Implementation

The results of the cross-board analysis provide seven practical guidelines for improving microcomputer implementation in the geography high school curriculum. There are four guidelines to the policy design level which are of a more global character and could be applied to other subject areas as well. At the local implementation level, three practical guidelines are derived from the findings. It is essential that these guidelines be individualized for the particular school board, school and teacher. Thus, one implementation challenge for administrators and teachers (who know best the specific settings in their working environment), is to incorporate the guidelines listed below into these settings. (Figure 6.1)

6.2.1 At the Design Level

At the policy design level the following is suggested:

I. Research on effective implementation

Research on effective implementation will serve as a base for a much needed positive implementation model to teachers - "microcomputer beginners", and encourage the process of implementing new technology.

II. Hardware/software standardization

Standardization of hardware/software is needed to enable free communication, exchange and usage. Decisions on how to deal with this problem, which is currently an acute issue, are paramount.

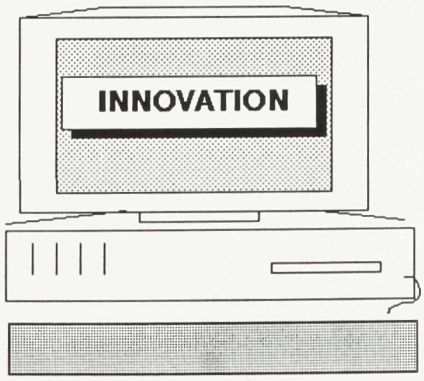
Figure 6.1 Implementation Guidelines

DESIGN LEVEL

- RESEARCH ON EFFECTIVE IMPLEMENTATION
- HARDWARE/SOFTWARE STANDARDIZATION
- PROVIDE READY-TO-USE TEACHING MATERIALS
- PROMOTE MICROCOMPUTER APPLICATIONS

USER LEVEL

- IMPLEMENT COMPUTERIZED UNITS INTO GEOGRAPHY CURRICULUM
- ACCELERATE TEACHERS' COMPUTER LITERACY
- APPOINT SCHOOL MICROCOMPUTER CO-ORDINATOR



III. New teaching aids

Provision of ready-to-use materials at the local levels - schools and school boards is required. Some examples include designed lessons, tested courseware and practical guides to teachers. These will then serve as an example for independent design of computerized units. Emphasis should be placed on the development of courseware for geography, which is presently retarded.

IV. Promote microcomputer use in teaching-learning

The use of microcomputers should be promoted in the sphere of social sciences by communicating directly to teachers some examples of such utilization. Active over passive introduction to microcomputer potential for geography is preferable, e.g., video demonstrations of microcomputer use in geography; hands-on experience with geographical software; and initiating discussions, rather that providing information in written form.

6.2.2 At the Local Level

At the local level three guidelines are as follows:

V. Implement computerized units into the geography curriculum

The realization that the microcomputer's capacity is relevant not only to mathematics, computer and business studies, but also in teaching/learning the social sciences in important. These include a variety of geography courses that are currently proposed in the guideline by the ministry, as well as the courses offered at schools. Boards should promote the implementation of computerized units into the geography courses curriculum, as was found in the case of CRCSSB. This should

include testing various geography courseware; selections most appropriate to the curriculum courseware; teacher training; provision of full instruction to the teacher; sufficient number of courseware copies and supporting materials.

VI. Accelerate teachers' computer literacy

One-to-one teachers' training is another important facet of the implementation process. Such training is to be distinguished from the workshop and seminar training for large groups of teachers and staff. Further, application courses concerned with the use of various geographic courseware, designed with respect to the curriculum, are in demand and should be offered.

VII. Appoint a school microcomputer co-ordinator

Each school should have a person administrating the computer lab(s). This individual will assist with decisions about hardware purchasing and allocations, concerns regarding training, maintenance and upgrading, managing the courseware, as well as dealing with unanticipated problems and questions about the hardware and/or software. By doing so, such a person will free the teacher of these duties and enable them to have more time for software exploration.

And finally, the challenges for both policy designers and users are to communicate and co-operate closely. In the future, both should concentrate on the monitoring of the implementation process in order to avoid problems from the past, and to facilitate this process in the future. At the same time, geography teachers should recognize the microcomputer's potential for teaching-learning geography, understand and use microcomputers with knowledge, confidence and skill.

6.3 Implications for Theories and Future Research

The traditional literature on innovations has been dominated by studies on adoption of new technology, based on the individual user decision [Rogers, 1971]. The research on implementation of educational innovations has emerged in the last decade. Implementation has been formulated as a process of change in the existing practice, which is characterized by a set of events occurring between the initial adoption of new technology and its eventual incorporation in the standard practice. During the implementation stage, success or failure of the effort is determined [Tranatzky at al., 1983].

Related research on educational innovations suggests that there is a contrast between the innovations initiated by agents external to schools (or school boards) organizations, and those initiated or supported locally, e.g., Cory, [1983], Cox, [1987], Yin and White, [1984] and Elkin [1983]. The results of the studies microcomputer implementation for geography by the four boards appear to support these conclusion. For the boards where no interest and action for microcomputer implementation in geography have occurred, the government's initial instigation has not succeeded. In contrast is the one board, where: strong interest in microcomputer introduction in all subjects, at the local level, and general support from the designers (ministry) level have merged, and consequently some promising initial result have become apparent.

In the future, some trends of microcomputer implementation should be monitored in relation to the hardware/software funding reduction for GEMS, i.e., from $65 million in 1990 to $31 million in 1991 (see Chapter 3 - Conclusion); and

the student enrolment trend in the boards. An increase in microcomputer acquisition and use during a difficult period of reduced funding, inadequate budgets and enrolment decreases, would be a positive sign for the future of microcomputers as educational technology.

The congruence of results does not eliminate the need for future corroboration of the microcomputer implementation process into the geography teaching-learning process. New empirical studies are needed to verify and refine the results and the understanding of the implementation process. Two directions of future research are advocated here.

The first is to develop a procedure for monitoring the implementation of the geography curriculum, the way it proceeds in the classroom. The impact of such monitoring will be in determining the differences between formal and implemented curriculum, and identifying the current problems in changing classroom practice, teaching materials, and teachers beliefs.

The second direction of proposed future research is to concentrate specifically on the development of new teaching lessons involving microcomputer use in geography and their implementation in a real classrooms settings. The implications of such efforts will provide examples of such use to teachers, which will influence the individual teacher decision for adoption of this new classroom practice on the basis of positive examples.

Above all, the process of implementation is one in which the teachers either do or do not learn new practices, and form new understandings about the effective use of microcomputers [Akker, 1988]. The implementation of microcomputers in geography, as most innovations in education, covers three spheres of change:

- teaching material, i.e., use of the hardware and software;
- teaching-learning practices, behaviours and activities; and
- teachers' beliefs.

The realization of the aim for effective pedagogic use of courseware in geography classroom will require intense and sustained efforts in all three spheres.

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Appendix A

Letter of Permission to the Boards of Education

Dear Board Officer :

I am a geography graduate student at Carleton University in Ottawa. In order to fulfil my degree requirements, I must complete an M.A. thesis. My research objective is to determine the factors influencing the effective implementation of microcomputers as an instructional tool in the high school geography curriculum.

In order to complete the study I need to consider several variables : computer accessibility, teachers' attitudes, skills and training. These variables are designed to serve as a base for the development of microcomputer implementation policy. I intend to obtain the data by mailing questionnaires to all high school full-time geography teachers in your board of education. The data will be essential for the completion of this research.

With this letter, I am asking for your permission to mail the questionnaires.
The copies of the original survey instrument and of the introductory letter to the teachers are attached. If you have any questions concerning this, please do not hesitate to contact my advisors: Dr. Taylor at 788-2519 and
Dr. Wilkinson at 788-3500.

Please, let me know your decision as soon as possible by either telephone or mail. I will greatly appreciate your consideration,

Respectfully

Lina Nikolova

Department of Geography
Carleton University
Colonel By Drive
Ottawa, Ontario
K1S 5B6

Office (613) 788-3961
Residence (613) 237-1320 ext.2450

Introductory Letter to the Teachers

26 January , 1990

Dear Geography Teacher :

I am conducting a case study concerned with the implementation of computers in the geography curriculum, as a part of my M.A. degree requirements. The primary research objective is to determine the factors for effective integration of microcomputers into the instructions of geography. Your School Board has agreed to support the study, and therefore I would kindly ask you to participate.

In order to complete the study I request your assistance in answering the following questionnaire. The purpose of the questionnaire is to solicit information about computer accessibility, attitudes, experience and training. Your response to this questionnaire is extremely important for the success of this study, which will contribute to the position of geography in high school curriculum. Your answers will remain strictly confidential, and the results will be published in aggregate form only. I would be grateful if you could take a few minutes to complete and mail the questionnaires back to me.

Your co-operation is needed and will be appreciated. The return of the completed questionnaire by February 15, 1990 to the address below, will greatly assist me.

Thank you very much for your time and assistance.

Sincerely :

Lina Nikolova
Graduate Student

Lina Nikolova
Department of Geography
Carleton University
Colonel By Drive
Ottawa, Ontario K1S 5B6

GEOGRAPHY TEACHERS COMPUTING SURVEY

The purpose of this survey is to gather information about geography teachers' experience with and interest in using a microcomputer as an instructional tool. This information will only be used to shape my decisions about a microcomputer implementation policy in the scope of this research. For the purpose of this survey microcomputers are defined as any small "personal" computer used primarily in the home, school or small business environment.

The questionnaire will take approximately 10 minutes to complete. Please return the survey in the Geography Department Head even if you do not finish it completely.

PART A: Background Information

These are general descriptive questions that will help the investigator to classify the responses. Please indicate the most appropriate answer to describe yourself at this time.

INSTRUCTIONS: Fill in or check appropriate blanks.

1. Total teaching experience
   ___ a. 1-4 years
   ___ b. 5-9 years
   ___ c. 10 <

2. Teaching experience in geography - all levels
   ___ a. 1-4 years
   ___ b. 5-9 years
   ___ c. 10 <

3. Teaching experience in geography - secondary level only:
   ___ a. 1-4 years
   ___ b. 5-9 years
   ___ c. 10 <

4. Please indicate your sex:
   ___ Male
   ___ Female

5. Highest level of education
   ___ a. Bachelor's - pass
   ___ b. Bachelor's - honours
   ___ c. Some graduate work
   ___ d. Master's
   ___ e. Beyond Master's
   ___ f. others, please specify

5.1 Please specify your degree speciality _____

6. Have you had any experience using a microcomputer?
   --- Yes
   ___ No

6.1 If "yes", please indicate the number of years: ___

7. Do you use a microcomputer at home:
___ Yes
___ No

7.1 If "yes", please specify which models _____
and the number of years _____

PART B: Your Opinions About Microcomputers in Geography Education.

Listed below is a series of statements about the use of microcomputers in geography education. You are asked to agree or disagree with each statement on a scale. There are NO RIGHT OR WRONG answers - only your personal opinion.

INSTRUCTIONS: Please indicate your personal opinion about each statement by circling one of the five possible choices.

SA - Strongly Agree
A - Agree
U - Uncertain or Undecided
D - Disagree
SD - Strongly Disagree

SA A U D SD	1. The microcomputer is a useful instructional tool.
SA A U D SD	2. Microcomputers are frustrating instructional tools.
SA A U D SD	3. Using microcomputers in school can isolate students from each other.
SA A U D SD	4. School Boards should purchase more microcomputers for instructional use.
SA A U D SD	5. I need more information about how to integrate microcomputers into my geography classes.
SA A U D SD	6. Geography teachers should be computer literate.
SA A U D SD	7. Using microcomputers can increase student interest in geography.
SA A U D SD	8. Geography is an appropriate subject for the use of microcomputer.
SA A U D SD	9. The microcomputer can be used as a tutor to present complex spatial concepts.
SA A U D SD	10.I prefer to use both the computer and traditional methods of teaching in my geography classes.

SA A U D SD 11. Implementation of microcomputers for instruction in geography should be encouraged.

SA A U D SD 12. Microcomputers are of little help in achieving the objectives of high school geography programs.

PART C: Access to Microcomputers and Scheduling Arrangements
The following questions are designed to measure your access to microcomputers and your experience in making arrangements to use the application labs if your school has one.

INSTRUCTIONS: Check appropriate blanks.

1. Are microcomputers available in your geography classroom?
   ___ Yes ___ No

2. Do you have access to microcomputers for teaching geography in a computer lab?
   ___ Yes ___ No

3. Do you use a microcomputer in your instructional program?
   ___ Yes ___ No

   If "Yes", then how often:
   ___ very rarely (2-3 times in total)
   ___ once or twice monthly
   ___ once a week
   ___ two or more times a week
   ___ daily

4. What hardware do you use:
   ___ APPLE/MACINTOSH
   ___ ICON
   ___ COMMODORE
   ___ IBM PC
   ___ Other

5. List the name brands of the software that you have used for geography instruction in your classes :

   _____
   _____
   _____

6. Scheduling Computers for Instructional Delivery and Student Use.

INSTRUCTION: Please circle the number closest to your perception of the present scheduling arrangements for:

A. Access to microcomputers for classroom instruction in your school.

easily arranged 1 2 3 4 5 arranged with difficulty

B. Access to microcomputers for student independent study.

easily arranged 1 2 3 4 5 arranged with difficulty

PART D: Your Computer Training

The following section is concerned with your formal computer training and your preferences for training and computer applications in use now and in the future.

INSTRUCTIONS: Fill in or check appropriate blanks.

1. Check the statements that apply to you:

___ a. I am mainly a self-taught learner
___ b. have received no training
___ c. have attended workshop(s) or seminar(s)
___ d. have received pre- or in-service training
___ e. have had a college course in using microcomputers
___ f. have received individual instruction from another computer user
___ g. other, please specify

2. How do you prefer receiving training for use of microcomputers?

___ a. Self-taught
___ b. One-on-one instruction by another microcomputer user
___ c. Programmed learning right at the computer
___ d. Workshop on microcomputers
___ e. College credit courses in microcomputers
___ f. Other, please specify _____

3. Specify the computer application you use now and those you would like to use in the future.

Use Now	Use in the Future	
___	___	1. Word Processor
___	___	2. Spread Sheets
___	___	3. Data Base Management
___	___	4. Computer Assisted Instr. (C.A.I.)
___	___	5. Test Score Analysis
___	___	6. Tele-Referencing
___	___	7. Desktop Publishing
___	___	8. Computer Graphics
___	___	9. Mapping Packages
___	___	10. Statistical Packages
___	___	11. Others _____
___	___	12. None

PART E: Comments.

Questionnaires do not always effectively cover all aspects related to a complex topic. If you have any comments or observations relating to computing and the teaching of geography, please feel free to add them here.

_____
_____
_____
_____
_____
_____
_____
_____

Please return the completed questionnaire to the Geography Department Head at your school before February 15, 1990.

Thank you for your participation!

Appendix B

Participants in the Interviews and the Survey

Candidates for the interviews were identified as having involvement with in one or another aspect of the microcomputer implementation process to date.

MINISTRY OF EDUCATION OFFICIALS

INTERVIEW SAMPLE

HURTUBISE, G. Education Officer, Computers in Education, Ministry of Education, Ottawa, Dec. 1989, Jan., Feb., March, April 1990.
LIPISCHAK, B. Director, Centre for Curriculum Resources and Technologies, Ottawa, April, 1990.
PERRY, M. Educational Officer, Social Sciences Curriculum Development, Ministry of Education, Ottawa, April 1990
PROULS, M. Educational Officer, Social Sciences Curriculum Development, Ministry of Education, Ottawa, April 1990
SMITH, L. Executive Manager, Computers in Education Centre, Ministry of Education, September, 1989
THOMSON, L. Software Development, Education Liaison and Exchange Branch, Ministry of Education, September, 1989
WOOD, M. Education Officer, Social Sciences Curriculum Development, Ministry of Education, Ottawa, April 1990

OTTAWA BOARD OF EDUCATION

INTERVIEW SAMPLE

BUIE, B. Librarian, Computer Resource Centre, 330 Gilmour Ave., Ottawa, November, 1989.
BURGAN, M. Geography Advisor, CJA Macdonald Centre, Ottawa, Nov. 1989 - 1990.
DIONNE, L. Research Assistant, SJA Macdonald Centre, Ottawa, Dec. 1989, January 1990.
LISTER, P. Planning Department, 330 Gilmour Ave., Ottawa, Nov. 1990
McVEY, M. Director of research and Professional Development, SJA Macdonald Centre, Ottawa, January 1990.
PURDY, M. Geography Departmental Head, Ridgemont HS, Ottawa, Nov. 1989.
VULLINGS, G. Co-ordinator, Computer Resource Centre, 330 Gilmour Ave., Ottawa, Nov. 1989.

SURVEY SAMPLE

AL PENNY, Geography Teacher, Woodroffe HS
BOB NEWELL, Geography Teacher, Hillcrest HS
BOB STEVENSON, Geography Departmental Head, Lisgar CI
BRUCE BAKER, Geography Departmental Head, Highland Park HS
DAVE ALLAN, Geography Teacher, Canterbury HS
DON LINDSAY, Geography Departmental Head, Hillcrest HS
FRANCINE GRINGRAS, Geography teacher, Hillcrest HS
GLEN CALDER, Geography Teacher, Rideau HS
GORD SORLEY, Geography Departmental Head, Canterbury HS
HARVEY DAVEY, Geography Departmental Head, Rideau HS
HORST SCHLEMMER, Geography Teacher, Nepean HS
IAN RAYBURN, Geography Teacher, Woodroffe HS
JOHN JACKSON, Geography Departmental Head, Brookfield HS
JOHN JARVIS, Geography Teacher, Brookfield HS
LARRY CREIGHTON, Geography Departmental Head, Nepean HS
LARRY JOHNS, Geography Teacher, Laurentian HS
LARRY MacNINCH, Geography Departmental Head, Woodroffe HS
LAVAL FOURNIER, Geography Teacher, Glebe CI
MARIE ANDREE SLEVAN, Geography Teacher, Nepean HS
MARY ANN SCIORTINO, Geography Teacher, Glebe CI
MICHAEL PURDY, Geography Departmental Head, Rigemont HS
NICOLE SARFELD, Geography Teacher, Brookfield HS
PAUL ASHWORTH, Geography Teacher, Nepean HS
PETER BANGS, Geography Departmental Head, Glebe CI
PETER OTTEN, Geography Teacher, Rideau HS
RIF QUADRI, Geography Teacher, Lisgar CI
ROD MATHESON, Geography Departmental Head, Laurentian HS
RON SAUNDERS, Geography Teacher, Rigemont HS
VIRGINIA LINDSAY, Geography Teacher, Glebe CI

OTTAWA ROMAN CATHOLIC SEPARATE SCHOOL BOARD

INTERVIEW SAMPLE

BUSSIERES, B. Co-ordinator, Computer Services, St. Thomas Aquinas Teachers Centre, Ottawa, Nov., Dec. 1989, April 1990
LOREN, N. Planning Department, Nov. 1989, Ottawa.
MANOR, M. Manager, Computer Services, 140 Cumberland, Ottawa, Nov. 1989.
MOORE, G. Director of Education, 140 Cumberland St., Dec. 1989, Ottawa
THOMAS, B. Geography Consultant, St. Thomas Aquinas Teachers Centre, Ottawa, Nov.- Dec. 1989, March-April 1990.

SURVEY SAMPLE

LES GORMAN, Geography Teacher, Notre Dame HS
MICHAEL NIHMEY, Geography Departmental Head, St. Patrik SS
NORM HARDER, Departmental Head, Notre Dame HS
PATTI SMYTH, Geography Teacher, Immaculate SS
VINCE IOZZO, Geography Teacher, St. Patrik SS

CARLETON BOARD OF EDUCATION

INTERVIEW SAMPLE

BUTLER, E. Planning Co-ordinator, Planning and Design Department, 133 Greenbank Rd., Ottawa, Nov. 198
CAMPBLL, D. Chairman of the Geography Heads Council, South Carleton HS, Nov. 1989, Feb., April 1990
CARRON, P. Co-ordinator, Instructional Services Program, 133 Greenbank Rd., Ottawa, Nov. 1989.
CLEGG, M. Research Associate, Research and Development Department, 133 Greenbank Rd., Ottawa, Jan.- Feb. 1990.
COUSINEAU, D.Manager, Computer services, 133 Greenbank Rd., Ottawa, Nov. 1989.
HIBBERT, H. Special Assignment Teacher, Microcomputer Services, 133 Greenbank Rd., Ottawa, Nov. 1989.
HINDLE, J. Consultant, Microcomputer Services, 133 Greenbank Rd., Ottawa, Nov. 1989.
MACLENNAN, L. Director of Education, 133 Greenbank Rd., Ottawa, Nov. 1989.
SANKER, Y. Research Assistant, Research and Development Department, 133 Greenbank Rd., Ottawa, Jan. 1990

SURVEY SAMPLE

ANDREY MACLEOD, Geography Teacher, Gloucester HS
BETH LALONDE, Geography Teacher, Cairine Wilson SS
CHUCK FRASER, Geography Teacher, Cairine Wilson SS
BOBBY ROMANKO, Geography Teacher, Bell HS
BRIAN CAIRNS, Geography Teacher, A.Y. Jakson SS
BRIAN SIMPSON, Geography Departmental Head, West Carleton HS
DAVID CAMPBELL, Geography Departmental Head, South Carleton HS
DAUB MONTEOMERY, Geography Teacher, A.Y. Jakson SS
DENIS MONNIN, Geography Departmental Head, Sir Wilfrid Laurier HS
ED MAC NIDER, Geography Departmental Head, Bell HS
EDITH MACNINCH, Geography Teacher, West Carleton HS
ELAINE OSBORNE, Geography Teacher, Gloucester HS
ELIZABETH GUTSELL, Geography Departmental Head, J.S. Woodsworth SS
GREG BRERETON, Geography Departmental Head, Colonel by SS
IAN MACDONALD, Geography Teacher, Marivale HS

JACEK FUDAKOWSKI, Geography Teacher, Sir Robert Borden HS
JACKIE RICH, Geography Teacher, Confederation HS
JENNY PERRY, Geography Teacher, Gloucester HS
JENS ANDERESEN, Geography Departmental Head, Cairine Wilson SS
JIM MCCONKEY, Geography Departmental Head, Osgoode HS
JIM MURAWSKY, Geography Teacher, Bell HS
JIM RONSON, Geography Teacher, South Carleton HS
JIM SPENCER, Geography Teacher, Sir Robert Borden HS
JOHN GANNI, Geography Teacher, Sir Wilfrid Laurier HS
JOHN KLASSEN, Geography Departmental head, Sir Robert Borden HS
JOHN ROSS, Geography Teacher, Osgoode HS
JOHN WEATHERHEAD, Geography Departmental Head, Confederation HS
MARK BOORGON, Geography Teacher, South Carleton HS
MARTE BELIVEAU, Geography Teacher, South Carleton HS
MICHAEL NORMANDIN, Geography Teacher, West Carleton HS
MONICA WALLACE, Geography Teacher, Gloucester HS
MONIQUE GRUBER, Geography Teacher, Sir Robert Borden HS
PAT PARKES, Geography Departmental Head, A.Y. Jackson SS
PAUL SIMARD, Geography Departmental Head, Gloucester HS
PETER DES BRISAY, Geography Teacher, Bell HS
PROSPER TORJMAN, Geography Departmental Head, Earl of March SS
RICHARD TRUDEL, Geography Teacher, Bell HS
RICK WILKINS, Geography Teacher, West Carleton HS
ROB DUQUETTE, Geography Teacher, J.S. Woodsworth SS
ROD CARSS, Geography Teacher, Earl of March SS
ROD FULLERTON, Geography Teacher, Confederation HS
SHELDON LEWIS, Geography Teacher, Sir Wilfrid Laurier HS
STUART NICHOLSON, Geography Departmental Head, Merivale HS
TONY MONSOUR, Geography Teacher, Earl of March SS
VIC PRISCEPIONKA, Geography Teacher, Merivale HS
WALDO HINDLE, Geography Teacher, Colonel By SS

CARLETON ROMAN CATHOLIC SEPARATE SCHOOL BOARD

INTERVIEW SAMPLE

BURRIDGE, J. Geography Consultant, Secondary Department, 128 Chesterton Dr., Ottawa, Dec. 1989 - April 1990
DALE, J. Co-ordinator, Computer Services, Secondary Program Development, Nov. 1989, April 1990
OLIVER, D. Manager, Computer Services, Ottawa, Nov. 1989

MARY RONDEAU, Librarian, Manager Telechart CANSIM, St.Marks HS, Ottawa, April 1990.
TOMLINSON, B. former Consultant, Contemporary Studies, Secondary Program Department, Ottawa, Dec. 1989
TRAVER WALKER, Co-ordinator, Contemporary Studies, Secondary Program Development
VIC D'AMICO, Superintendent of Curriculum, Ottawa, Jan. 1990

SURVEY SAMPLE

BETTY CRAIG, Geography teacher, St. Marks HS
BRIAN HARRISON, Geography Teacher, St. PIUS X
DAVID DIBSON, Geography Teacher, St. Paul's HS
DENISE ANDRE, Geography Departmental Head, St. Marks HS
JIM KENT, Geography Departmental Head, St. Matthew HS
GARY YATES, Geography Departmental Head, St. Paul's HS
KAREN GUILLET, Geography teacher, St. Matthew HS
L. SCOTT, Geography Teacher, St. Marks HS
MICHAEL DAVIS, Geography Teacher, L.B. Pearson Catholic HS
MONA BRENNAN, Geography Teacher, St. Pius X
PHIL YATES, Geography Departmental Head, St. Pius X
RAY BERGIN, Geography Teacher, St. Pius X
ROD HAMMILL, Geography Teacher, St. Paul's HS
RON LAKUSIAK, Geography Teacher, St. Matthew HS

OTHER PARTICIPANTS
DICK MANSFIELD, Geography Professor in Faculty of Education, Queens University, Kemptville, April 1990

Appendix C

Questionnaire Responses

PART A General Information About Geography Teachers

1. Total teaching experience

	OBE	CBE	ORCSSB	CRCSSB
1-4 years	5%	12%	0%	n/a
5-9 years	0%	7%	0%	n/a
> 10 years	95%	81%	100%	n/a

n/a data not available

2. Teaching experience in geography - all levels

	OBE	CBE	ORCSSB	CRCSSB*
1-4 years	5%	14%	20%	26%
5-9 years	11%	12%	40%	37%
> 10 years	84%	74%	40%	37%

* from total of 11 responses

3. Teaching experience on geography - secondary level

	OBE	CBE	ORCSSB	CRCSSB
1-4 years	5%	14%	40%	50%
5-9 years	11%	12%	20%	40%
> 10 years	84%	74%	40%	10%

4. Gender

	OBE	CBE	ORCSSB	CRCSSB
Male	83%	77%	80%	58%
Female	17%	23%	20%	42%

5. Highest level of education

	OBE	CBE	ORCSSB	CRCSSB
BA pass	5%	12%	0%	25%
BA Honours	32%	51%	20%	50%
Graduate Work	32%	24%	20%	8%
MA	32%	14%	40%	17%
Beyond MA	n/o	n/o	n/o	n/o

5.1 Degree Speciality

	OBE	CBE	ORCSSB	CRCSSB
In Geography	89%	86%	50%	60%
Others	History	History	Phis. Ed.	History
	English	Economics	Sociology	English

6. Teachers with microcomputer experience

	OBE	CBE	ORCSSB	CRCSSB
	89%	79%	80%	83%
Average in years	4.5	3.3	3.1	3.0

7. Home microcomputer users

	OBE	CBE	ORCSSB	CRCSSB
	53%	40%	20%	16%
Average in years	5.7	2.4	4.0	3.5

PART B **Teachers' General Opinions About Microcomputers**

SA - strongly agree
A - agree
U - undecided
D - disagree
SD - strongly disagree

STATEMENTS

		OBE*	CBE**	ORCSSB	CRCSSB
1. The microcomputer is a useful instructional tool.	SA	11%	33%	60%	33%
* from a total of 18	A	78%	43%	20%	50%
** from a total of 42	U	11%	21%	20%	17%
	D	0%	3%	0%	0%
	SD	0%	0%	0%	0%
2. Microcomputers are frustrating instructional tool.	SA	0%	2%	0%	0%
* from a total of 17	A	29%	25%	40%	17%
** from a total of 40	U	41%	15%	20%	8%
	D	24%	45%	20%	58%
	SD	6%	13%	20%	17%
3. Using microcomputers in school can isolate students from each other.	SA	0%	5%	0%	0%
* from a total of 17	A	47%	15%	20%	25%
** from a total of 41	U	18%	24%	20%	17%
	D	29%	37%	40%	50%
	SD	6%	19%	20%	8%
4. School boards should purchase more microcomputers for instructional use.	SA	11%	36%	40%	42%
* from a total of 18	A	67%	33%	60%	33%
** from a total of 42	U	11%	14%	0%	25%
	D	11%	12%	0%	0%
	SD	0%	5%	0%	0%
5. I need more information about how to integrate microcomputers into my geography classes.	SA	17%	39%	60%	33%
** from a total of 41	A	56%	39%	40%	50%
	U	5%	5%	0%	27%
	D	11%	14%	0%	0%
	SD	11%	3%	0%	0%

6. Geography teachers should be computer literate.	SA 28%	18%	40%	25%
	A 56%	60%	60%	58%
	U 5%	15%	0%	17%
** from a total of 40	D 11%	7%	0%	0%
	SD 0%	0%	0%	0%
7. Using computers can increase student interest in geography.	SA 11%	24%	40%	50%
	A 78%	46%	60%	42%
	U 11%	24%	0%	8%
** from a total of 41	D 0%	3%	0%	0%
	SD 0%	3%	0%	0%
	SA 22%	33%	80%	50%
8. Geography is an appropriate subject for the use of microcomputers.	A 72%	50%	20%	34%
	U 6%	14%	0%	16%
	D 0%	3%	0%	0%
** from a total of 42	SD 0%	0%	0%	0%
9. The microcomputer can be used as a tutor to present complex spatial concepts.	SA 22%	22%	80%	25%
	A 33%	35%	20%	50%
	U 39%	28%	0%	25%
** from a total of 40	D 6%	12%	0%	0%
	SD 0%	3%	0%	0%
10. I prefer to use both computer and traditional methods of teaching in my geography classes.	SA 39%	40%	60%	25%
	A 39%	27%	40%	50%
	U 11%	23%	0%	17%
** from a total of 40	D 11%	10%	0%	8%
	SD 0%	0%	0%	0%
11. Implementation of microcomputers for geography should be encouraged.	SA 22%	22%	60%	17%
	A 72%	57%	40%	85%
	U 6%	14%	0%	8%
** from a total of 42	D 0%	7%	0%	8%
	SD 0%	0%	0%	0%
12. Microcomputers are of little help in achieving the objectives of high school geography programs.	SA 0%	0%	0%	0%
	A 0%	7%	0%	8%
	U 11%	20%	20%	8%
** from a total of 40	D 78%	50%	20%	42%
	SD 11%	23%	60%	42%

PART C Data on Microcomputer Usage (frequency) and Accessibility - Quantitative Aspects.

1. Teachers using microcomputers in their instructional program

OBE*	CBE**	ORCSSB	CRCSSB
39%	36%	0%	67%

* from a total of 18 responses
** from a total of 42 responses

2. Frequency of microcomputer usage*

	OBE	CBE	ORCSSB	CRCSSB
very rarely	86%	73%	0%	75%
once or twice monthly	14%	27%	0%	25%
once a week	N O		U S E	
two or more times a week	N O		U S E	
daily	N O		U S E	

* calculated from the total number of teachers using microcomputer in their instructions

3. Percentage of microcomputers available in geography classrooms

OBE*	CBE**	ORCSSB	CRCSSB
17%	19%	0%	0%

* from a total of 18
** from a total of 42

4. Teachers with access to microcomputers for teaching geography on a computer lab

OBE*	CBE**	ORCSSB	CRCSSB
72%	43%	40%	100%

* from a total of 18
** from a total of 42

5. Teachers' perceptions on access to microcomputers for instruction

	OBE*	CBE**	ORCSSB	CRCSSB
Easily Arranged				
1	0%	22%	0%	0%
2	18%	10%	0%	17%
3	30%	15%	20%	25%
4	24%	13%	20%	33%
5	38%	40%	60%	35%
Arranged with difficulty				

* from a total of 17
** from a total of 40

6. Teachers' perceptions on access to microcomputers for student independent study

	OBE*	CBE**	ORCSSB	CRCSSB
Easily Arranged				
1	6%	17%	20%	17%
2	36%	17%	20%	17%
3	10%	25%	0%	16%
4	18%	15%	40%	25%
5	30%	26%	20%	25%
Arranged with difficulty				

* from a total of 17
** from a total of 40

PART D Data of Teachers' Training and Training Preferences

1. Existing Training	OBE	CBE**	ORCSSB	CRCSSB
Self-taught	48%	53%	20%	25%
No training	11%	11%	40%	8%
Workshops and/or seminars	84%	61%	20%	42%
Pre-/In- service training	16%	18%	40%	42%
College/univers. courses	5%	5%	20%	17%
One-to-one instruction	53%	47%	40%	75%

2. Training Preferences	OBE	CBE**	ORCSSB	CRCSSB
Self-taught	16%	18%	0%	0%
One-to-one instruction	68%	68%	40%	92%
Programmed learning	32%	29%	80%	25%
Workshops and/or seminars	38%	16%	60%	67%
College/univers. courses	0%	8%	0%	0%
Other	0%	5%#	0%	0%

** from a total of 38
# CBE : help from his son

3.Microcomputer Applications Now and in the Future -Quantitative Aspect

	OBE		CBE*		ORCSSB		CRCSSB	
	Now	Future	Now	Future	Now	Future	Now	Future
Word Processor	74%	26%	62%	28%	20%	40%	67%	25%
Spread sheets	26%	11%	21%	41%	0%	40%	67%	34%
DB Management	16%	37%	21%	28%	20%	20%	25%	58%
C.A.I.	21%	21%	13%	41%	0%	80%	25%	41%
Test Score An.	16%	32%	27%	38%	0%	40%	34%	25%
Tele-Referenc.	0%	11%	0%	3%	0%	40%	0%	17%
Desktop Publi.	5%	16%	5%	15%	0%	20%	0%	25%
Computer Graph.	5%	53%	18%	44%	0%	80%	17%	58%
Mapping Pack.	0%	68%	21%	59%	0%	100%	17%	92%
Stat. Pack.	5%	53%	19%	46%	20%	80%	17%	50%
Others	0%	0%	3%#	0%	0%	0%	0%	8%#
None	26%	5%	23%	13%	60%	0%	17%	0%

* from a total of 39
# CBE : Simulations
# CRCSSB : Simulations

Geography Courseware

The following is a list with geographic courseware that was identified by the teachers participating in the survey as used in teaching.

Each program is listed by:
- NAME
- PRODUCER
- COMPUTER CONFIGURATION
- GRADE LEVEL(S)
- TYPE OF SOFTWARE

Ottawa Board of Education

"GLOBAL ANALYSIS PROGRAM"
P. Jennings, J. Prince, S. Wobschall, L.B. Pearson HS, Prentice-Hall;
PET/C64;
Senior
Geographical Statistical Analysis

"GUSHER"
author unstated
COMMODORE
Intermediate
Simulation - Drilling and marketing of oil

"LIFE EXPECTANCY" and "LIFESTYLE"
author unstated
PET/C64
Intermediate, Senior
Drill and Practice - answering questions concerning his/hers habits, lifestyle and health

"MALI LIFE"
Jo Ann Wilton and Matthews
PET/C64/ICON
Intermediate and Senior
Simulation - Agriculture in less-developed countries

"MOVEMENT of ICE"
Ian Wright, revised by T. Walker
PET/C64
Intermediate, Senior
Simulation - Demonstrates the movement of a mass of ice internally and across the land surface

"VOLCANO SIMULATION"
Victor T. Albino, revised by C. Foster
PET/C64
Intermediate, Senior
Simulation

Carleton Board of Education

"DEMOG I"
LONGMAN MICRO SOFTWARE
APPLE/PET/ACORN/C64
Intermediate, Senior
Drill and Practice - Forecasting the effects of demographic transition

"DEMOG II"
LONGMAN MICRO SOFTWARE
APPLE/PET/ACORN/C64
Senior
Simulation - Projects population changes

"DEMO-GRAPHICS"
CONDUIT
APPLE/IBM-PC
Senior
Modelling - Various graphical presentations of population data

"MALTHUS"
LONGMAN MICRO SOFTWARE
APPLE/ACORN/RML network
Senior
Simulation - Population growth and food and energy supplies

"MINING GAME"
Science North
MACINTOSH
Senior
Simulation

"RICE FARMING"
LONGMAN MICRO SOFTWARE
APPLE/ACORN/RML network
Intermediate, Senior
Simulation Game - Farm management in India

"SIMCITY"
Maxis/Broderbund
MACINTOSH
Intermediate, Senior
Simulation - Urban planning

"WORLD GEOGRAPHY"
INTELLECTUAL SOFTWARE
APPLE IIE, II+, IIc, 48k; MACINTOSH
128k/IBM-PC, 64k
Intermediate, Senior
Simulation - Travelling in Europe and learning about cities, and significant geographical features

Carleton Roman Catholic Separate School Board

"BARTLETT SAGA"
author unstated
ICON
Intermediate, Senior
Simulation - The Bartlett Family - life decision making

"B.C. FOREST"
author unstated
COMMODORE PET
Intermediate
Simulation

"B.C. LUMBERING"
John Buckley, Keith Donald, Ying N. Szeto
Gus Bazps/Association of Large
School Boards of Ontario
PET
Intermediate
Simulation - Decision making and forest management

"CANADIAN SHIELD RAILWAY"
Eduvision Inc.
ICON
Intermediate
Simulation

"CANSIM"
Statistics Canada
Intermediate, senior
Data Base - Census data

"CARGO SAILOR"
Ministry of Education of Ontario
ICON
Intermediate
Simulation Game

"DECIDE YOUR EXCELLENCY"
Interactive Image Technologies,
TV Ontario
ICON
Intermediate, Senior
Simulation - Decision making about agrarian reform, adult literacy, military repression, desertification and cultural development in a developing country

"OFF-SHORE FISHING"
The Association of Large School
Boards of Ontario
PET, ICON
Intermediate
Simulation - Discovering the key environmental and operational aspects of off-shore fishing