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ABSTRACT

The second volume of a three-volume report on a three-year study of the use of computers in secondary school classrooms, this document contains the principal investigators' reports in five sub-project areas. The overall purpose of the project, which was conducted by the education faculty at the University of Western Ontario, was to examine the effects of computer use on classroom teaching and learning and on the structure and presentation of curricular materials. Following a site leader's report, the five areas covered in this volume are: (1) computer aided learning in art, including themes identified through application of grounded theory methods, levels of student cognitive activity, and reports on teacher and student satisfaction; (2) computer use in the areas of technological and family studies, including levels of cognitive activity, gender-based differences, and special hardware and software needs particular to the subject areas; (3) computers in history, geography, and social studies, including the influence of subject subcultures and teaching styles, the traditions of teaching the subject, and their impact on computer use; (4) teacher use of computers for curricular and instructional management; and (5) use of spreadsheets in all classes, including levels of cognitive activity and the stages teachers and students pass through in their use of the computer. Each of these sections covers research methodology, provides recommendations, and includes references. (Contains 66 references.) (KRN)

RUCCUS
Research Unit on Classroom Learning and Computer Use in Schools

The Use of Computers for Classroom Learning

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Summative Report, Volume 2 from the project:
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ABSTRACT

This three-year study, carried out by the Faculty of Education, University of Western Ontario, in co-operation with the Board of Education for the City of London, and the Ontario Ministry of Education, undertook to assess and examine the use of computers in classroom learning at the secondary level; to further assess and examine how computer practice might be adapted to maximize learning opportunities; and to provide a series of case studies of how innovative activities in the school with regard to computers can be initiated, implemented and sustained.

This summative report is organized into three volumes: Volume 1 reviews the context of the research project: its organization, the basis of the research strategy that was used, and the character of the schools, teachers and students involved. Volume 2 contains the Principal Investigators' reports from each of the sub-projects. Volume 3 explores a number of research themes, and summarizes the findings and recommendations which have emerged.

This volume begins with a report from the Liaison for the Board of Education, giving a progress report on the steps taken by the Board during the project. Included are sections on the hardware and software installations, in-service training, and present Board policies regarding the use of computers in education.

In the art area, Clark reviews a number of emergent themes identified through his application of grounded theory methods to the study of CAL. These include similarities in the participating art classes in teacher backgrounds, classroom environments and dynamics, and curricular structures. Clark identifies a number of levels of cognitive activity by students using the computers, and reports that teachers and students were generally satisfied with their participation. However, he also raises some cautionary notes regarding the cost-effectiveness of CAL.

Rhea reports that computers found a wide range of implementations in the areas of technological studies and family studies. Similar to the art area, there were activities observed at a number of different levels of cognitive complexity. Gender-based differences in use became apparent in some of these classes, and the special needs of these areas suggested that they might need particular kinds of hardware and software.

Goodson and Mangan report on the social studies area. They found that the influence of subject subcultures and established styles of teaching had a profound influence on the use of computers in geography and history classrooms. The traditions of the subject, including a concentration on factual content and a Socratic pedagogy, were seen to shape the ways computers were used, and to some extent, to minimize their impact on these classrooms.

Pitman reports a wide range of uses by teachers for the purposes of curricular and instructional management. These include marks management, word-processing, classroom preparation and even materials management. He cautions, however, that classroom computers have not yet achieved their potential as productivity tools due to a number of impediments to their use.

Finally, Rutledge and Rhea review the progress of spreadsheet use by students in all classes involved in the project. Using the UNCAL typology which was also used by several of the other investigators, he identifies a number of levels of cognitive activity connected with the use of spreadsheet software in class. He also notes that both teachers and students can be expected to pass through a number of stages in the sophistication of their computer use, and that most are still at an early stage. With more sophisticated software, however, they will probably be ready to move on soon.

At the end of each Principal Investigator's section, there is a series of recommendations regarding future educational computer use. These reports also pave the way for the examination of over-arching theoretical issues which makes up Volume 3.

- August 30, 1991

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2.1.1 INTRODUCTION

I assumed the role of the Board Site Leader during the second year of the project. My role was to be a liaison with the principal investigators and researchers at the Faculty of Education, to provide professional development for the staff who were participating in the project, to make any necessary acquisitions and to ensure that the equipment was functioning properly. The particular hardware and software used in the project and the distribution of the equipment has been described fully by the Board's first site leader in the First Interim Report (Nielsen, 1989). Following, I have provided some comments on my areas of involvement.

2.1.2 OPERATING SYSTEMS

For the duration of the project, the operating system of the ICON computers seemed to be in a constant state of change. Every few months a new or revised operating system was developed to support new features or a "patch" diskette was sent out to remedy problems encountered in the operation of the computer network. While each new version or update had its benefits, most also have had their own glitches or problems. In solving some problems on the system, others were sometimes created and then a subsequent diskette would be sent out to "fix" the new problems created. However, once a network was up and running and some time and energy was expended to correct any difficulties, few problems were encountered in its use by the teachers and students.

Printing on the network created the most significant difficulties. To enable the users to print on printers attached to various workstations, it was necessary to use a software package which queued the printing jobs as they were received by the fileserver and then sent them out to the appropriate printer. The program *PrintNet* was chosen at the outset of the project for this task and it worked quite well, although at times there were long waits (up to a minute) before printers would begin printing. Although initially *PrintNet* would not print *Spectricon* pictures on the Hewlett Packard Paintjet printer, the developers of *Spectricon* wrote a printer file that solved the problem.

When the network was updated with the new operating system, 4.01, it was found that *PrintNet* would no longer work effectively and a new program, *PrintWare*, was then installed as the network printer controller. Although this program worked well for most OESS programs, anything that was printed from a DOS program under QDOS was sent to the default printer located at the fileserver, rather than at the printers connected to workstations. While this was not a big problem in the lab setting, it required a lot of walking to retrieve the printed documents in the cluster setting where the computers were located in several classrooms. The solution to this problem was to reinstall an older version of the operating system and go back to using *PrintNet*.

As we near the completion of this project another change has been announced. The *Ambience* environment for the ICON is being updated with *Iconlook*. Hopefully this interface will solve some of the difficulties experienced in the use of *Ambience* but it will also require more professional development of the staff so that they can learn how to use *Iconlook* and then teach their students how to use it.

2.1.3 FILESERVER STORAGE

Each school was equipped with one network fileserver with sixty-four megabytes of memory. The first partition of the hard disk was used to store the application programs and the second partition was set up for user files. The limited amount of hard disk storage space created difficulties from time to time. Each time a new program was added, the amount of free space had to be monitored. When the 90% level was reached, decisions had to be made as to which programs would be removed and which programs would be kept. However, as much of the OESS subject-specific software was used only for relatively short periods of time during each semester, this was not a major problem, other than taking the time to install and deinstall programs. Many of these programs were used only for a certain part of the classes' curriculum and therefore might be needed for only one or two weeks per semester.

Teachers had to be continually encouraged to remove student users at the end of each semester so that the user space could be maximized. Most students did not "clean up" their work space on a regular basis, and often there were several files that students had used to create their final product that remained on the system until the student was removed at the end of the semester. This was especially true for the *Spectricon* drawing program. Throughout the process of creating the piece of art, many students saved each successive stage of the artistic creation under a new name. This was appreciated by the teachers so that they could see the various stages that the students went through in creating the art. However, when the files were not erased it tended to fill up the amount of available memory. This situation needed to be monitored on a regular basis.

Some solutions to the hard disk storage problems could include:

a. having floppy disk drives readily available on which all student and teacher users could store their files. This would mean the attaching of floppy drives to the workstations rather than having just one floppy drive on the fileserver.
b. purchasing fileservers with larger amounts of memory. Programs that are being developed now tend to be increasingly sophisticated and require more memory and greater speed.
c. being able to limit the amount of space that each student has access to on the hard disk. This would necessitate each student prioritizing the information that they would keep on their space and deleting some files or storing them on diskette when their space was filled. The DOS user space under QDOS is currently set up with the ability to vary the amount of space available to users for their DOS files and this seems to work quite well.

2.1.4 PROFESSIONAL DEVELOPMENT

The professional development of teachers is of vital importance to ensure successful integration of computers into the school setting. It is necessary to not only assist the teachers in becoming familiar with the use of the hardware and software in the initial stages of implementation but also to provide long-term support. This project has demonstrated that there is a definite need for on-going assistance with the technical aspects as well as with methodology for the integration of computers into the curriculum. "Practitioners often need more than one year to grow comfortable with any change. For the majority of teachers, the first year is a time of trial and experimentation." (Guskey, 1990).

The teachers received an intensive four days of workshops at the beginning of the project to familiarize them with the hardware and some of the software available on the networks. After those first sessions, most of the teachers requested that the workshop sessions be limited in time and extent. It was agreed that workshops should be no longer than one half day and that there should be time allowed for teachers to explore the new software on their own. Teachers also asked to have some time to share their experiences in using the computer in their classroom with the other teachers.

Once teachers received basic training in using specific software packages and began to use them in their schools, many requests were received seeking assistance in solving some difficulties that arose, or advice on how to use or modify a particular portion of the software so that it would fit with specific curriculum uses. Usually when teachers encountered problems they asked for immediate assistance. The teachers often referred to the problems as "urgent". It was found that many of these difficulties could be solved over the phone, especially as the teachers became more familiar with the computer systems. The time lines for solving these problems is crucial. If a student or teacher is using the computer to do a particular aspect of their program and cannot use it for some technical reason, a great amount of frustration can be encountered and there is the possibility that the computer will not be used next time unless a quick fix can be achieved. An attempt was made to make the computer technology as "transparent" as possible and to emphasize its use as a tool by both teachers and students. The reference to "transparent" technology is interpreted as meaning that the computer user is almost unaware of the equipment that is being used. The emphasis is on the process and the output, not on being dazzled by the power and intricacies of the machine, or being frustrated by difficulties in using the hardware and software.

It has been found that "one shot" workshops are not very effective in having teachers acquire the skills necessary to operate the computer hardware and software. It takes a long-term approach for many teachers to change their attitudes and behaviours so that they can effectively integrate computer technology into their teaching. While some teachers are extremely enthusiastic from the outset and are willing to devote a lot of time and energy to learning about computers, others are hesitant and require repeated, on-going assistance to develop a sense of comfort and skill in using computers so that they can begin to use them with their classes.

We attempted to hold all staff development sessions in non-threatening situations that provided for a wide range of computer expertise. The most effective learning took place when teachers were allowed to follow a problem-solving mode. For example, when the teacher had a particular task that he or she wished the computer to perform for them or if they wanted their students to be able to complete a particular task, they tended to learn more in a shorter period of time than if they were assigned a problem by a workshop leader. It is important however to initially provide the teachers with some basic information about the various programs so that they know the basic functions and limitations of the software and can then develop their own "problems" to solve. Often, the individual teacher's learning about specific details in using programs came a few days after a group staff development session. Some time to "play" with the program and to develop questions about specific parts of the program frequently led to one-on-one meetings with the workshop leader to further explore the software. The importance of having a knowledgable computer liaison person available for this type of staff development cannot be over emphasised. "Several researchers suggest that nearly all teachers need social support, coaching and sustained classroom practice to transfer knowledge to their classrooms." (Lipman & Robb,1991).

Individuals providing staff development for computers must recognize that there are a variety of learning styles and modalities and some provision needs to be made to accommodate these variations in the teachers with whom they are working. The process of acquiring the necessary computer skills, transferring them to teaching strategies, and then integrating the teaching strategies into the curriculum is a long, slow process for most teachers. Several opportunities for attending workshops as well as the provision for continued individual contact with a knowledgeable source seems to work well in assisting even the most hesitant of teachers.

2.1.5 EDUCATIONAL PHILOSOPHY AND POLICY STATEMENT

The first interim report (Goodson, Mangan and Rhea, 1989) contained the "Directions for Instructional Software and Computers, Version 3" (DISC 3) which the Board of Education for the City of London was operating under at that time. In 1991 DISC 3 was revised and DISC 4 has been approved and adopted. The changes include:

a. combining the statement and philosophy for the Elementary and Secondary panels.
b. removing any references to specific subject areas.
c. recognition of the need to replace computer equipment that is obsolete or beyond economical repair.
d. recognition of the need to investigate the potential of existing and future technology.

Following is an excerpt from the document.

DIRECTIONS FOR INSTRUCTIONAL SOFTWARE & COMPUTERS
EDITION 4

PART A: PHILOSOPHY

1.0 PREFACE:

1.1 With the rapid increase in the amount of computer equipment and software within the London Board, there is a need to formally clarify the philosophy, directions for acquisition and implementation and operational practices regarding this technology.

1.2 Computer Assisted Learning (CAL) is a dynamic process which will periodically require modifications to either computer equipment or software.

1.3 To enhance program delivery, there is an ongoing need to investigate the potential of existing and future technology.

2.0 BASIC EXPECTATIONS:

2.1 All students shall have the opportunity, to the full extent of their abilities and within the resources of the Board, to become knowledgeable and creative in their use of computers as personal learning tools. See *Policy/Program Memorandum no. 91, 1987* from the Ontario Ministry of Education for further clarification.

2.1.1 The principle of equal opportunity of access for each student shall be attained throughout the system.

2.1.2 Teachers developing or delivering programs for students in the Early Years and Formative Years shall include computer applications in the areas of study defined in *The Formative Years* and *Education in the Primary and Junior Divisions*.

2.1.3 Teachers developing or delivering courses in the Transition Years and Specialization Years shall incorporate computer applications.

2.2 The **Mission Statement** and **Educational Philosophy** of the Board reflects the need for flexibility and autonomy in learning.

2.2.1 Students shall be given opportunities to use computers to assist in the development of skills in writing, composing, exploring, drawing, calculating, analyzing, problem solving, role playing and accessing information sources. This can be accomplished through the use of word processors, simulation programs, graphics editors, sound editors, spreadsheets, database managers and other software which supports creative thinking.

2.2.2 Students should explore the ways in which network configurations can provide a medium of communication with peers and teachers both within and beyond the school building.

2.2.3 Students should be given the opportunity to access computer equipment on a standalone basis where appropriate.

2.3 All program development and delivery shall emphasize the broad integration of computer experiences into the school curriculum. Courses offered under the Computer Studies Guideline, 1983, shall continue to focus on computer architecture, programming and applications software.

2.4 All Board program documents which are developed shall include specific statements on the most appropriate computer applications for students.

3.0 COMPUTERS IN SCHOOLS AS LEARNING TOOLS

3.1 The acquisition of effective learning skills should lead young people to become lifelong, self-directed problem solvers. Such skills shall be independent of any subject orientation. The process of learning needs to be emphasized as much as the content. The integration of computer technology into the learning process shall be compatible with this view of the learner.

3.1.1 Teachers, acting as facilitators, shall ensure that computer uses and applications are combined with other program delivery strategies to support:

3.1.1.1 the accommodation of a variety of learning styles, abilities and needs;

3.1.1.2 the individualization of student learning activities;

3.1.1.3 the development and honing of the skills of critical inquiry, information management, computation and communication;

3.1.1.4 the attainment of program objectives;

3.1.1.5 the development and refinement of the skills involved in successfully collaborating with others; and

3.1.1.6 the encouragement of students' positive attitudes towards themselves and towards learning.

PART B: DIRECTIONS FOR INSTRUCTIONAL COMPUTERS

1.0 PLACEMENT IN SCHOOLS

1.1 For CAL purposes, the Board shall purchase computer equipment for which sufficient high quality software is available to effectively support local program delivery.

1.2 For CAL purposes, the Board shall install networked equipment in each building. For special purposes some standalone computers may be installed in addition to the network.

1.3 For special education purposes, the Board shall continue to purchase a variety of computer equipment and software to satisfy unique, specific and approved program needs.

2.0 TYPES OF COMPUTER EQUIPMENT

2.1 The types of computer equipment to be purchased in subsequent years shall be determined by Program Services through an annual assessment of current implementation procedures and an awareness of changes in technology.

2.2 As new equipment is purchased for CAL purposes, the present CAL equipment shall be centralized in fewer schools within the corresponding panel until all schools are equipped with networked configurations.

3.0 SCHOOL BASED RESPONSIBILITIES

3.1 When an installation is planned for a school, the principal shall select a person or committee to act as a liaison for CAL with Program Services staff.

3.2 Liaison persons at the school level will assist in managing CAL resources.

3.3 School principals may continue to purchase software from school accounts for which they are responsible. The software shall:

3.3.1 support established classroom program objectives;
3.3.2 encourage the organization and communication of ideas;
3.3.3 focus on the process of learning as well as the content;
3.3.4 support a diversity of learning styles and abilities;
3.3.5 encourage social interaction and peer tutoring;
3.3.6 be user friendly; and
3.3.7 avoid prejudice, bias and discrimination;
3.3.8 be compatible with that school's computer operating system.

4.0 STAFF EDUCATION AND DEVELOPMENT

4.1 Program Services staff shall provide in-service training of staff at schools which are in the process of receiving computer technology for CAL.

4.2 Program Services staff shall provide on-going support for program implementation using computer assisted learning.

4.3 Each school's CAL liaison person or committee will receive in-service training in the operation and maintenance of the network.

2.1.6 REFERENCES

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2.2 ART
by Roger Allen Clark

Computer Aided Learning (**CAL**) and its counterpart Computer Aided Instruction (**CAI**) are not new phenomena in either elementary or secondary education. At this time, substantial research into CAL and CAI curricula is available to both researchers and practitioners. It must be stressed at the outset, therefore, that this project contained, within its structure, fundamental positions already established within the fields of CAL and CAI. This project was not focused upon a replication of these established positions even though the Canadian context of the project could have justified such a research activity; this project was conceptually an extension of established findings—an extension into curricular territory curiously foreign to both CAL and CAI: art.

2.2.1 THEORETICAL FOUNDATIONS

Blomeyer (1988) has compiled an overview of research findings related to CAL and CAI; those unfamiliar with the field are directed to this valuable article.

2.2.1.1 CAL Paradigms

Within the context of this project, CAL was conceptualized within *a taxonomic model related to levels of cognitive activities* (MacDonald, Atkin, Jenkins, and Kemmis, 1977). The model encompassed four curricular paradigms:

a. **Instructional CAL**, involving drill, practice, and tutorial activities;
b. **Revelatory CAL**, utilizing simulations and *trial-and-error* exercises;
c. **Conjectural CAL**, relating to the creation of *new* knowledge; and,
d. **Emancipatory CAL**, encompassing activities that free individuals from routine, time-consuming tasks.

This taxonomic model was developed by researchers during the mid-1970s in the United Kingdom. The project team, involved with the **UNCAL** (Understanding Computer Aided Learning) evaluation of the British National Development Program for Computer-Assisted Learning (**NDPCAL**), used qualitative techniques within 27 case studies to ascertain contextual elements relevant to both successful and unsuccessful school, military, and business instructional computing projects.

2.2.1.2 Learner/CAL Interactions

Central to the theoretical underpinnings of this research project, as well, was *a functional typology of learner/CAL interactions* (Kemmis, Atkin, and Wright, 1977). This UNCAL typology involved five kinds of interactions:

a. **Recognition** tasks, often involving *yes-or-no* types of learner responses. No comprehension levels are determined through these kinds of interactions;
b. **Recall** tasks, typically requiring *fill-in-the-blank* kinds of responses. Again, no levels of comprehension are involved although the assimilation and/or memorization of content can be addressed;
c. **Reconstructive Understanding** tasks, usually of the *multiple-choice* variety. Student comprehension of program content within this category can be assessed through processes requiring semantic manipulation;

d. **Global Reconstructive** tasks, often relating to learner-directed interaction processes. Student responses in this category are open-ended; their assessment involves not only the *correct* application of program content but extension requiring analytic, synthetic, and creative solutions; and,
e. **Constructive Understanding** tasks, which are even more open-ended than those involved in global reconstruction. Here, original knowledge or constructions are required; they are assessed relative to their application to relevant functional frameworks.

A common criticism of CAL activities is that they typically involve only low-order cognitive skills (Bok, 1986). Furthermore, CAI within educational contexts is inexorably linked to pedagogic strategies only slightly updated from the days of Skinnerian teaching machines.

Given the endurance and popularity of such criticisms, it is surprising that CAL has remained entrenched within relatively narrow disciplinary contexts. Equally puzzling is the reluctance of less objectified disciplines, such as art, to take advantage of the creative and expressive capabilities unique to modern microcomputers. One of the most exciting features of the project was a fundamental desire among all of the Principal Investigators to encourage the use of microcomputers within a broader, more cognitively rigorous disciplinary scope.

2.2.2 OBJECTIVES

The following objectives were related to this specific project *only*. Please refer to the reports prepared by the other Principal Investigators in order to ascertain objectives and activities undertaken within the project-at-large.

This research project was committed to:

a. **collecting and analyzing baseline data** obtained by the Research Officers at the two research sites. The data involved was related to personnel profiles, physical plant capabilities and operation, student population characteristics, curricular overviews, and teacher/student attitudes/experiences with art-based CAL.
b. **providing descriptive case studies** related to the development and implementation of art-based CAL at the two research sites. These studies were conducted using Grounded Theory methodologies (Glaser and Strauss, 1967) and were dually tracked between teachers and students. The two sites provided investigative opportunities within the following comparative categories: visual art and Graphic (vocational) art; junior and senior secondary grades; advanced and general level courses of study; novice and moderately experienced teachers; and, novice and moderately computer literate students.
c. **investigating art-based CAL** within the following curricular paradigms: Instructional, Revelatory, Conjectural, and Emancipatory CAL.
d. **exploring art-based CAL** in relation to the following student/computer interactions: Recognition, Recall, Reconstructive Understanding, Global Reconstructive, and Constructive Understanding Tasks.

2.2.3 METHODOLOGY

2.2.3.1 Baseline Data

The baseline data, obtained at the outset of the project, produced information related to personnel profiles, physical plant capabilities and operation, student population characteristics, curricular overviews, and teacher/student experiences with art-based CAL.

The data was used to describe pre-operational conditions existing at the research sites and to provide a basis for comparative analyses during consecutive phases of the study.

2.2.3.2 Selection of Research Sites

In addition to the collection of baseline data, this project required documentation and analyses related to the development and implementation of art-based CAL at two research sites. The dual site approach was selected in adherence to consistent research findings which indicated that subgroups within research populations targeted for the initial introduction of CAL should not be narrowly delineated (ie., remedial populations, enriched programming, upper income school districts, *et cetera*). The literature showed that any reliance upon restricted subgroup populations could critically cripple subsequent attempts to institutionalize computer activities throughout a given school system due to biases and impressions that such activities are *only for slow learners*, the *gifted*, and so on (Blomeyer and Bright, 1987; Blomeyer, 1985; Meister, 1984; Kemmis, Atkin and Wright, 1977).

Accordingly, two separate research sites were selected for the project. The sites were selected through consultation with other Principal Investigators and the sponsoring board of education. The availability of funds for the acquisition of appropriate types and quantities of computer hardware/software was a significant factor in the deliberations.

a. **Brock** was a large technical secondary school. The school had traditionally held a very dominant position within the local school system ever since its construction after World War I. The art department was made up of two separate, but allied, streams. The visual arts portion offered academic art courses and the graphic arts section provided vocational art programs. There were seventeen teachers within the overall Department, each member highly skilled in either Visual or graphic arts. The school building was well-equipped and computers were already being used within some of the art courses.

The selection of Brock as a primary research site was almost a foregone conclusion at the outset of the project. Its size, dual art department curricula, numerous teachers, and existing computer programming provided ample reasons for its inclusion in the study. Those same positive but atypical factors, however, necessitated the selection of an additional research site, one that more closely resembled a typical Ontario secondary school.

b. **Tecumseh** was a moderately large, academic secondary school. The school offered only visual arts courses and had a relatively small, but highly dedicated teaching staff of art specialists. Computers were not originally used within the art program although the art facilities, in general, were reasonably up-to-date and extensive.

The paired research sites provided a rich field for comparative analyses. The uniqueness of the Brock art programming and on-site facilities were well balanced with the relatively modest but more generalizable features of the Tecumseh art department.

2.2.3.3 Development of Methodology

At the outset of the project, each Principal Investigator had the opportunity to independently conceptualize and present to the collective research team the methodology that seemed most appropriate for each individual study. As one might have expected, the preliminary drafts of each project contained methodological elements at variance with the others; however, within a relatively short space of time, some common structures appeared such as the UNCAL typology of CAL/Learner interactions and the related taxonomic model of CAL-related cognitive activities. Perhaps even more important was the early emergence of a common inquiry focus:

> **the preparation of concurrent, qualitative case studies focused upon the changes made to student and teacher learning strategies induced through the introduction of CAL in a variety of traditional and non-traditional subject areas.**

The primary research methodology used within the art-based research project was Grounded Theory, a qualitative framework developed initially by Glaser and Strauss (1967). After the RUCCUS Research Officers had collected data from both Brock and Tecumseh for **one** school semester, speculative **emergent categories** of data arose from a careful analysis of the limited, available research entries. *At that time, however, it was noted that*:

a. the emergent categories could only be tentatively listed. It was anticipated that some of the categories that appeared to be significant would recede in importance as more data became available; conversely, subsequent data collection could result in an advancing profile for issues that did not appear to be initially significant; and,
b. the categories could **not** be subjected to even a preliminary assessment. No analysis of emergent categories could be undertaken until a point of **data saturation** had been achieved. The emergent categories would become *saturated* with data when no **new** information was being gleaned from the research field. Until that point was reached, the research team had to conscientiously refrain from reaching or accepting even the most tentative of conclusions.

The following list of tentative emergent categories was formed at the conclusion of the first implementation block:

a. the roles that **student backgrounds** and **teacher profiles** played in the acceptance of computers within classroom contexts;
b. the effects that specific subject-based **classroom environments** and **classroom dynamics** had upon the selection of pedagogic strategies related to the introduction of CAL; and,
c. the elements of **curricular structures** embedded within particular school subjects as they pertained to issues such as the *lab versus classroom* computer siting dilemma and the selection of computer hardware/software.

The following emergent categories were closely tracked during subsequent implementation blocks at Brock and Tecumseh:

a. **student backgrounds**;
b. **teacher profiles**;
c. **classroom environments**;

d. **classroom dynamics**; and,

e. **curricular structures.**

It was stressed that these five emergent categories were generic clusters, each providing a flexible umbrella for a variable number of sub-categories. For example, one issue investigated by the RUCCUS team centred around whether or not male students worked with computer systems more readily than female students did. Gender-based issues, such as this, did not form an emergent category of their own within the analysis of the art classes; rather, they were dealt with within either **student backgrounds**, **classroom dynamics**, or both, as appropriate. It was understood that the initial list of emergent categories would expand only if:

a. the number of sub-categories became excessive within a single heading;

b. the nature of the sub-categories indicated that a realignment of collected data into different groups was advisable; or,

c. entirely new categories emerged as the data collection continued.

Although unlikely, it was accepted that one or more of the five initial categories could become saturated with data at a very early stage in the overall project. Had this occurred, it would have indicated that the emergent category was either of minor importance within the context of the project-at-large, or, of significant importance but simply and strongly assessed.

Finally, it was understood that the categories would be filled with data related specifically to the art-based project. The RUCCUS team would be simultaneously tracking over-arching issues that spanned the breadth of the project-at-large. The data collected at that level would be analyzed by the Research Officers and their conclusions disseminated in other portions of the final Ministry report.

2.2.4 RESEARCH COMPLETED: IMPLEMENTATION BLOCK 1
Second Semester, 1988/89 School Year

2.2.4.1 <u>In-Service Sessions</u>

During the early part of this school semester, all of the participating teachers were given their official in-service activities. The sessions were conducted by the board of education's liaison. The classroom teachers were released from their teaching duties for four full days; these days were spread over four consecutive weeks.

Two particular aspects related to the in-service program could be highlighted. Firstly, the teachers were introduced to the ICON system by the liaison *en masse*, that is to say, all of the participants undertook identical workshop exercises. Secondly, the teachers were presented with an overview of the ICON system that corresponded to their *middle* status: they were given more information about the system than students would normally receive but not as much as an in-school computer technician would typically require.

Both of the participating art teachers spoke highly of the role played by the liaison. For the most part, they felt that they had been adequately prepared for the initial implementation of this research project. They did, however, offer some suggestions as to how future computer in-service sessions could be improved.

Wendy Farnham, the participating practitioner at Brock, offered the following comments:

a. 6 or 7 sessions were necessary, rather than just 4;
b. full-day sessions were somewhat fatiguing;
c. teachers could have been sub-divided by subject area into smaller groups for *drill and practice* time;
d. information about Robotel should have been included; and,
e. instruction related to animation would have been helpful.

Barb Cunningham, the art teacher at Tecumseh, suggested that 4 additional days for drill and practice would have been helpful and could have reduced the rushed pace of the instructional blocks.

Finally, both teachers felt that more time should have been given to practice exercises related specifically to the software available to them as participants in the art project.

2.2.4.2 **Initial Implementation of CAL Activities**

2.2.4.2.1 *Brock*

Wendy Farnham's students were already familiar with those rudiments of computer graphics applicable to MacIntosh (Mac) systems. The students had used the Mac computer, located in the art room itself, for the production of text, poster headings, business cards, and so on.

Wendy Farnham revises her graphic art curricula annually, so introducing some ICON-based activities to her classes in April and May was not a problem. For her Special art class, Wendy Farnham developed a curricular assignment which required the students to create personalized illuminated letters using *Spectricon*. This project was preceded by several class periods during which the students explored and familiarized themselves with the ICON system. These preliminary experiences with the ICON computer involved both self- and peer-taught drills.

Wendy Farnham used the computers herself throughout the school year, preparing curriculum documents, recording students grades and attendance, as well as demonstrating the various graphic art capabilities of the computer.

These computer activities which occurred at Brock during the first semester of implementation could be placed within the following typology of cognitive activities (MacDonald, Atkin, Jenkins, and Kemmis, 1977):

a. **Instructional CAL**, involving drill, practice, and tutorial activities, was undertaken at Brock during the students' initial introduction to the ICON system. This instruction took the form primarily of teacher-lead demonstration classes.
b. **Revelatory CAL**, utilizing simulations and *trial-and-error* exercises, occurred immediately after the teacher-lead Instructional CAL classes were finished. These Revelatory activities involved self- and peer-taught drill sessions using *Spectricon*.
c. **Conjectural CAL**, relating to the creation of *new* knowledge, was the dominant form of cognitive activity. Using *Spectricon*, the students were to creative unique graphic designs that corresponded to specific instructional cues.
d. **Emancipatory CAL**, encompassing activities that freed individuals from routine, time-consuming tasks, was conducted primarily by the teacher at Brock, Wendy Farnham.

The computer activities implemented at Brock could also be analyzed in terms of various learner/CAL interactions using the UNCAL typology developed by Kemmis, Atkin, and Wright (1977):

a. **Recognition tasks**, often involving *yes-or-no* types of learner responses;
b. **Recall tasks**, typically requiring *fill-in-the-blank* kinds of responses; and,
c. **Reconstructive Understanding tasks**, usually of the *multiple-choice* variety. These are the three lowest levels given within the UNCAL typology. None of these learner/CAL activities occurred to any significant degree at Brock.

Immediately after the teacher-lead computer demonstration periods, the students at Brock encountered:

d. **Global Reconstructive tasks**. Typically, such tasks are learner-directed and are open-ended; their assessment involves not only the *correct* application of program content but extension(s) requiring analytic, synthetic, and creative solutions. The Brock students were involved quickly in self-and peer-taught exercises that provided *dry runs* for the anticipated graphic art assignment. At the conclusion of these Global Reconstructive activities, the highest category of learner/CAL interaction was experienced, namely,
e. **Constructive Understanding tasks**. The computer-generated illuminated letters produced by the Brock students met the criteria established for inclusion in this UNCAL category: original knowledge or constructions were required, and assessment was directly related to their application to relevant functional frameworks.

In summary, therefore, only global reconstructive and constructive-understanding tasks were employed by the students at Brock and, of the two categories, the latter dominated the school semester.

2.2.4.2.2 *Tecumseh*

The pre-implementation environment at Tecumseh differed substantially from that at Brock in that the students at Tecumseh had no previous experience with computers within a secondary school art setting. It was true, however, that many of Barb Cunningham's Grade 13 students had used Commodore and Atari computer systems for playing video games at home, and that they had created literary texts using such computer systems during their years in elementary school.

Despite this basic difference, the introduction of the ICON computers at Tecumseh followed a very similar pattern to that already described at Brock. Consider these structural parallels:

a. senior students were selected for inclusion in the project, in this case, Grade 13 students;
b. the students were given short, initial exposures to the ICON system through teacher-centred demonstrations;
c. these demonstrations were followed by self- and peer-directed drill and practice sessions;
d. the bulk of the school time devoted to computer art involved individualized, creative assignments; and,
e. the participating teacher used the ICON system for the preparation of handouts and data related to student progress.

A few noteworthy differences did appear when the implementation case studies were compared. For example, at Tecumseh:

a. only one computer system was available to the students. At Brock, the Mac computer was used by the students, as well as the ICON machines;
b. the students at Tecumseh worked on individualized studio and/or art history projects, many of which were designed by the students themselves. For example, one student worked at reproducing a Mondrian painting on the computer screen. Another student took a Representational painting and converted it into a Cubist study. In both cases, the computer projects capitalized on the ICON's ability to easily construct geometric forms, and they both provided a sound curricular bridge linking art history and studio production. The students at Brock produced individual design solutions as well, however, they worked within a singular project structure developed and assigned by the teacher; and,
c. Barb Cunningham had her students use the ICON computers to record personal information as the term progressed. She had hoped to have the students complete a questionnaire via the computer, however, technical problems precluded tnis type of student-based Emancipatory CAL.

The implementation strategies used at Brock were analyzed using two typologies- one involving cognitive activities and the other related to learner/CAL interactions. The data from Tecumseh can be scrutinized using the same two formats:

a. **Cognitive Activities:**
The computer implementation at Tecumseh relied heavily upon Conjectural CAL; some of the individual projects developed by the students have been described. To a limited extent Emancipatory CAL was employed both by the participating teacher and by the students themselves. Instructional and Revelatory CAL activities were not emphasized.
b. **Learner/CAL Interactions:**
Recognition, Recall, and Reconstructive Understanding Task interactions occurred infrequently at Tecumseh. As was the case at Brock, the students employed Global Reconstructive tasks during self- and peer-directed *trial run* activities and primary usage was made of Constructive Understanding activities.

2.2.4.3 Quinte Lighthouse Project Presentation

On June 21, 1989 all participating teachers from the board of education, along with the RUCCUS team and the Principal Investigators from the faculty of education, met during a working luncheon at the Education Centre. The function offered the assembled group two valuable opportunities:

a. the participants had a chance to meet and review the progress made during the first semester of CAL implementation; and,
b. the group was able to meet Dr. Sandra Wolfe, a Policy Advisor from the Ontario Ministry of Education, and to hear her speak about the recent Lighthouse School Project at Quinte Secondary School in Belleville. Her report took the form of a video presentation augmented with a question-and-answer period during which time she fielded questions from the London teachers.

The video was made up of taped interviews, primarily of teachers at Quinte Secondary School, conducted at the conclusion of the Ministry project. The videotape was most interesting to see, however, the information received was not very directly applicable to this London-based Ministry initiative since:

a. Lighthouse projects are not structured upon research methodologies so the findings remain largely anecdotal and inherently subjective; and,
b. the art program at Quinte was one of the few curricular areas not involved in the computer implementation program.

2.2.4.4 <u>Emergent Issues During Block 1</u>

During the first school semester of implementation, several difficulties related to the ICON computer system appeared. For the art classes in particular, one major technical problem surfaced early in the semester and remained unresolved by the end of the 1988/89 academic year. The colour printers purchased by the board of education were discovered to be incompatible with the *Spectricon* program. Since *Spectricon* was the primary software package purchased for the art project, this incompatibility was a severe disappointment for the project participants. It was discovered, however, that the printers would work with the *IPaint* program so the art students were able to obtain some printouts during May and June. The developers of *Spectricon* committed themselves to remedying this problem and pledged to have the colour printers working with the *Spectricon* program by September, 1989.

As was the situation generally throughout the project-at-large, the art classes experienced a significant number of computer "crashes" during the first semester of implementation, as well as "disappearing" and "frozen" cursors. These annoying situations occurred less frequently as the semester progressed.

It should be emphasized here that both of the participating art teachers spoke glowingly of the support provided during the semester by the board of education's liaison.

Another ICON-related issue arose regarding the procedures put in place by the board of education for student logins. The initial AMBIENCE-based procedure was very time consuming, however, the board was reluctant to approve QNX-based student logins. The installation of a new fileserver at the beginning of the next semester reduced the time required for AMBIENCE-based logins and the problem diminished in importance.

The issue of access by participants to data collected by the RUCCUS team and to drafts of the interim reports prepared by the Principal Investigators was discussed at the conclusion of this semester. After lengthy debates, it was resolved that such access would be facilitated in increasing measure as the project-at-large progresses and as the Principal Investigators anticipate the writing of summative reports.

Both participating teachers introduced the ICON system to their students with truly remarkable ease and professional skill and each considered ways to increase computer usage in their classrooms during the next school year.

Wendy Farnham, the art teacher at Brock, hoped to have her students create full colour prints for commercial paste-ups when the colour printers were properly functioning. She also wanted to transfer student computer work to videotape for public display; any animated sequences would, however, have to remain computer-based in order to retain links to the fileserver. *Spectricon* would remain the primary software package for her classes next year although she also wished to introduce spreadsheets to her students in order to teach them how to prepare billing dockets and time sheets.

At Tecumseh, Barb Cunningham anticipated that *Spectricon* would be used again by her senior students. One change for next year, however, would be her intention to make the computer assignments compulsory for all students in order to coax shy or fearful individuals to overcome their anxieties regarding CAL. Barb Cunningham also contemplated using the *IMark* program herself in order to record student grades and to engage in other emancipatory-based activities.

2.2.5 RESEARCH COMPLETED: IMPLEMENTATION BLOCK 2
First Semester, 1989/90 School Year

2.2.5.1 Refinements to the Collection of Field Data

The collection of field data by the RUCCUS research team during the first implementation block set a high standard for both the quantity and quality of the data obtained. The Research Officers consistently managed to provide a unifying data collection system for the project-at-large while, at the same time, to offer allied approaches tailored to each of the Principal Investigators' specific theoretic foundations.

During the second implementation block the RUCCUS team further expanded its operation through the introduction of an in-house database system. Using *DataPerfect* software as a base, the researchers developed a data retrieval system employing over forty keywords, each derived from critical elements of the project-at-large. The *DataPerfect* software package was purchased for this Principal Investigator and the art project became an integral part of that addition to the RUCCUS data collection system.

The in-house database system augmented, not replaced, the original methods used by the RUCCUS team for the collection of field data. During the second implementation block, data related to the art project also included:

a. extensive interviews with the cooperating teachers;
b. interviews with students selected as "key informants" (Glaser and Strauss, 1967); and,
c. transcribed versions of classroom visitations.

It should be clearly stressed that the high quality of service provided by the RUCCUS Research Officers continued to be one of the critical factors related to the successful implementation of the art project.

2.2.5.2 Refinements to Technical Elements of the Project

The second implementation block saw the installation of the following pieces of computer hardware/software (originally expected at the initiation of the project-at-large):

a. the introduction of one **CD-ROM** unit in the Tecumseh library and another in the Brock computer laboratory; and,
b. the implementation of a new version of *Spectricon*, capable of operating effectively with the colour printers.

Wendy Farnham, the participating teacher at Brock, reported that she only used the Robotel unit a few times in the computer laboratory for the following reasons:

a. the students had to wait to login until the Robotel unit was operating. This created an atmosphere of frustration at the start of the class period and fostered *off-task* behaviour;
b. her art students were unaccustomed to being interrupted as a collective group by the teacher during time set aside for personal studio work; and,
c. teacher-centred pedagogic strategies, such as Robotel-based instruction, were not her most favoured approaches in art. Wendy Farnham felt more comfortable engaged in one-on-one *coaching* at students' desks.

The CD-ROM units at both school sites were installed as stand-alone units on the **PW-300** (DOS) machines. The cooperating teachers completed an in-service training session on the system, including the use of the *Grolier Encyclopedia* software. No references, either by students or by teachers, to the CD-ROM units were found in the art data collected that semester; therefore, it was safely concluded that the CD-ROM units had little impact within the art portion of the project-at-large.

By contrast, the installation of the new version of *Spectricon* (capable of operating with the colour printers) had a great impact within the art project. Considerable levels of frustration were noted during the previous semester when such print capabilities were not possible. Although some students indicated that they had gradually adjusted to the notion that computer graphics were inherently suited to viewing within the monitor screen, most of the curricular applications devised by the teachers had been dependent upon hard copy prints for collages, layout paste-ups, packaging, and so on. The new version of *Spectricon*, therefore, was crucial to the successful implementation of art curriculum planned for the second research semester.

2.2.5.3 The Cooperating Teachers as Reflective Practitioners

The research methodologies used within the art project were predicated upon two qualitative perspectives:

a. a reliance upon the cooperating teachers as *key informants* within a Grounded Theory framework (Glaser and Strauss, 1967); and,
b. a conceptualization of teaching as an inquiry-driven, reflective practice (Schön, 1983; 1987).

With these two qualitative perspectives in mind, a special meeting between the two cooperating teachers and the Principal Investigator was arranged at the end of the second implementation block during the week devoted to school examinations. The purpose of the meeting was to reflect individually and collectively about implementation activities during the term and to pose questions related to those activities for collective consideration, perspective, and reaction.

The first portion of the meeting took place at a very informal location: the home of the Principal Investigator. Both teachers appeared early, laden with examples of student computer work and curriculum documents. The ensuing discussions were characterized by elements of professional cooperation, inquiry, respect, and a real sense of celebration. Noticeably absent were many of the qualities so often associated with the evaluation of teacher performance by external agents: defensive reactions, provocative criticisms, competitive attitudes, and professional posturing. The second portion of the meeting occurred at a local dining establishment where members of the group continued to bond professionally through the development of further insights into the lived experiences each has brought to his or her educational practice. The important roles played by the **life histories** of educators has been increasingly the focus of many qualitative researchers (Cole, 1991; Goodson, 1988).

The cooperating teachers were anxious to share (not compare) examples of student computer work completed during the previous semester. Wendy Farnham, from Brock, brought samples of the following computer assignments:

a. design work based upon mirror imaging;
b. the production of personal Christmas greeting cards;
c. value exercises involving computer ramping/brush work;
d. computer-generated prototypes for commercial packaging;
e. tonal studies subjected to manual tinting; and,
f. general computer-based drawing exercises.

Barb Cunningham, the cooperating teacher from Tecumseh, shared student works based upon the following computer assignments:

a. uniquely arrayed colour wheels designed by students;
b. animal drawings (to support Animal Week at Tecumseh);
c. derivative cartoons;
d. non-objective exercises which required students to utilize as many *Spectricon* features as possible;
e. quadratic compositions in which the basic form was treated to specific colour combinations in each section;
f. designs based upon any one of six techniques for acquiring the illusion of perspective;
g. a seriated project: completion of a collage; segment of collage subsequently reproduced on a computer; and, an enlargement of the collage section painted in tempera; and,
h. general computer-based drawing exercises.

Student-Produced Images from Wendy Farnham's Art Class

Figure 2.1: Mirror Image Design

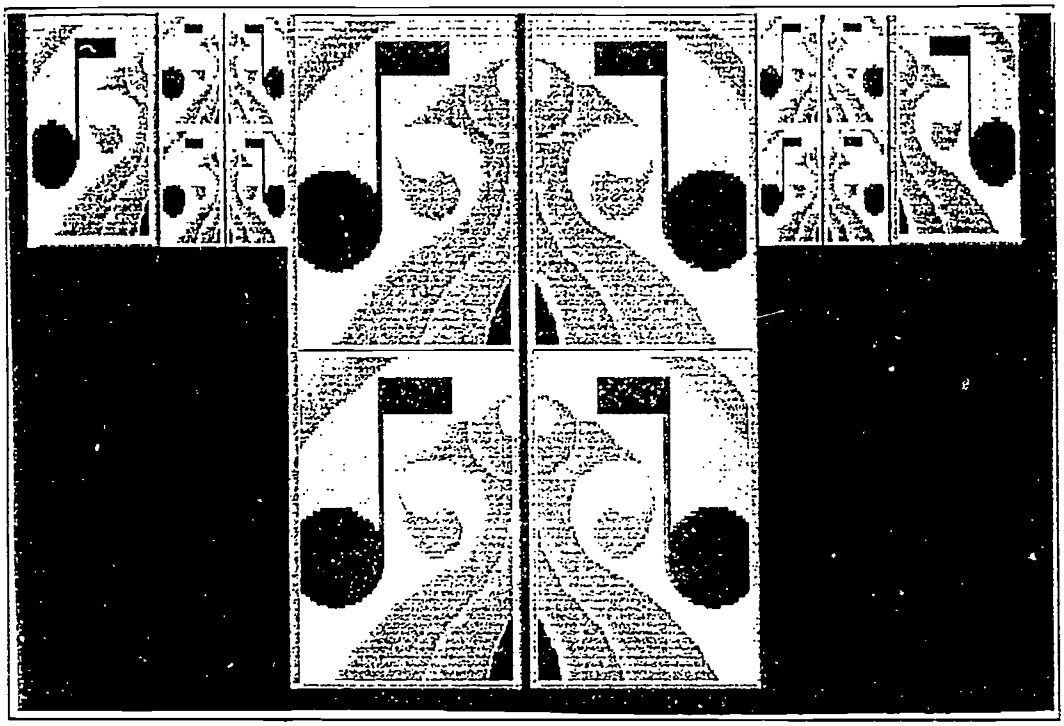
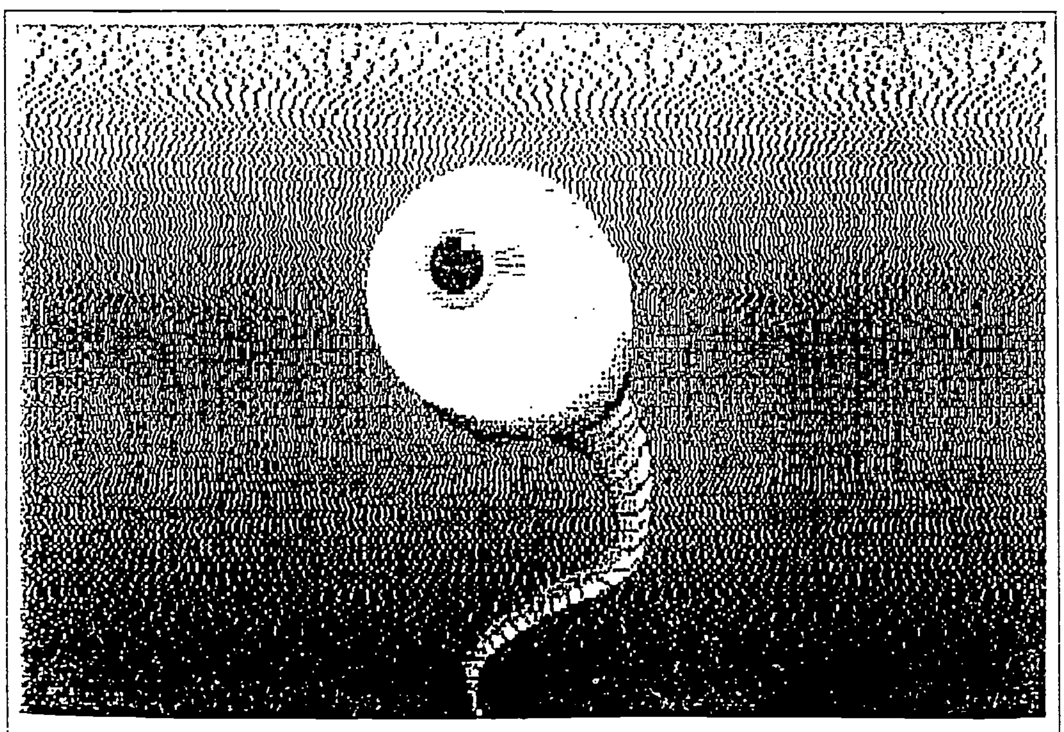


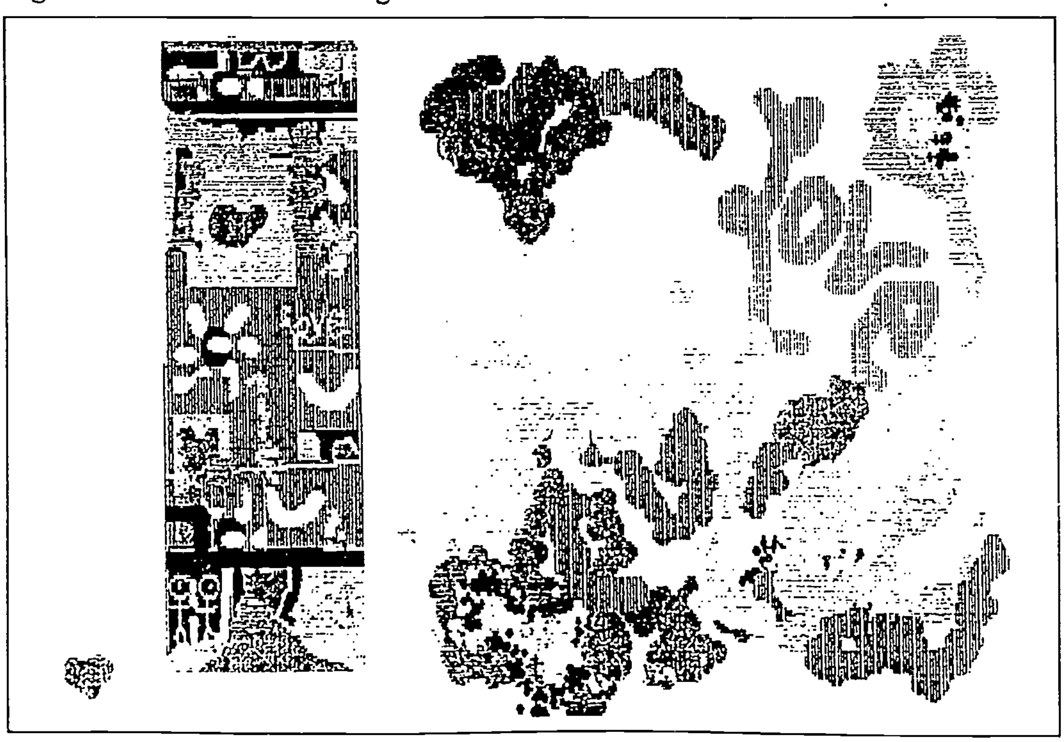
Figure 2.2: Ramping Effects



Student-Produced Images from Wendy Farnham's Art Class (Cont'd)

Figure 2.3: Tonal Study

Figure 2.4: General Drawing



Student-Produced Images from Barb Cunningham's Art Class

Figure 2.5: Colour Diagram

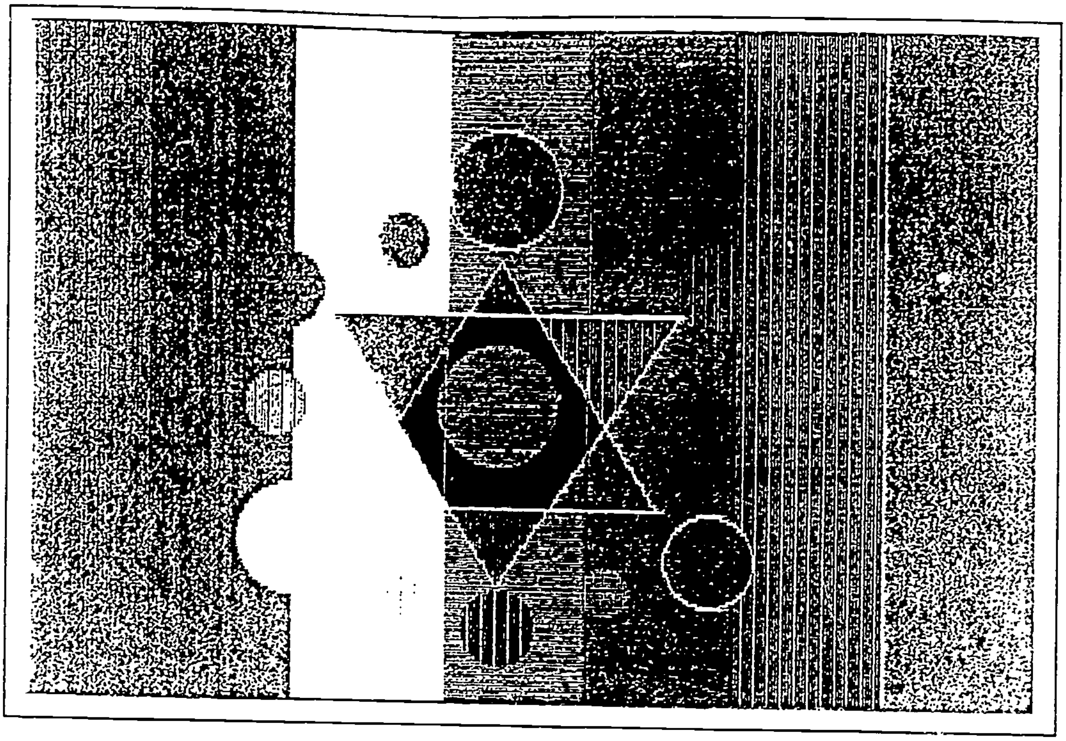
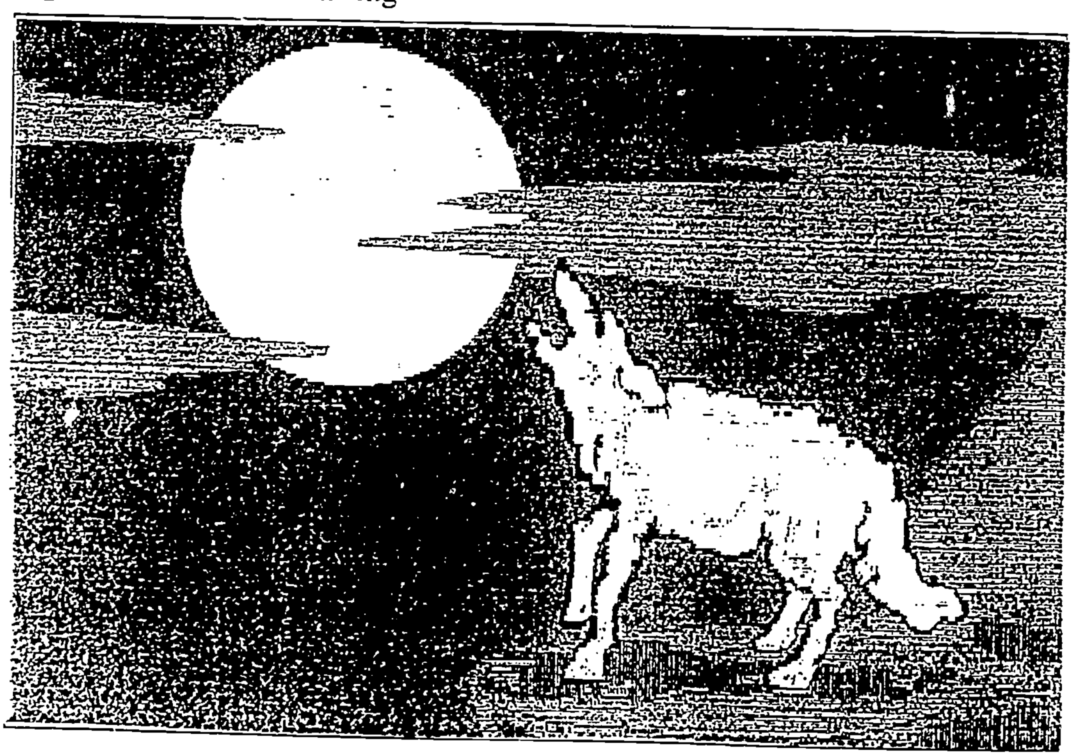


Figure 2.6: Animal Drawing



Student-Produced Images from Barb Cunningham's Art Class (Cont'd)

Figure 2.7: Multiple-feature Drawing

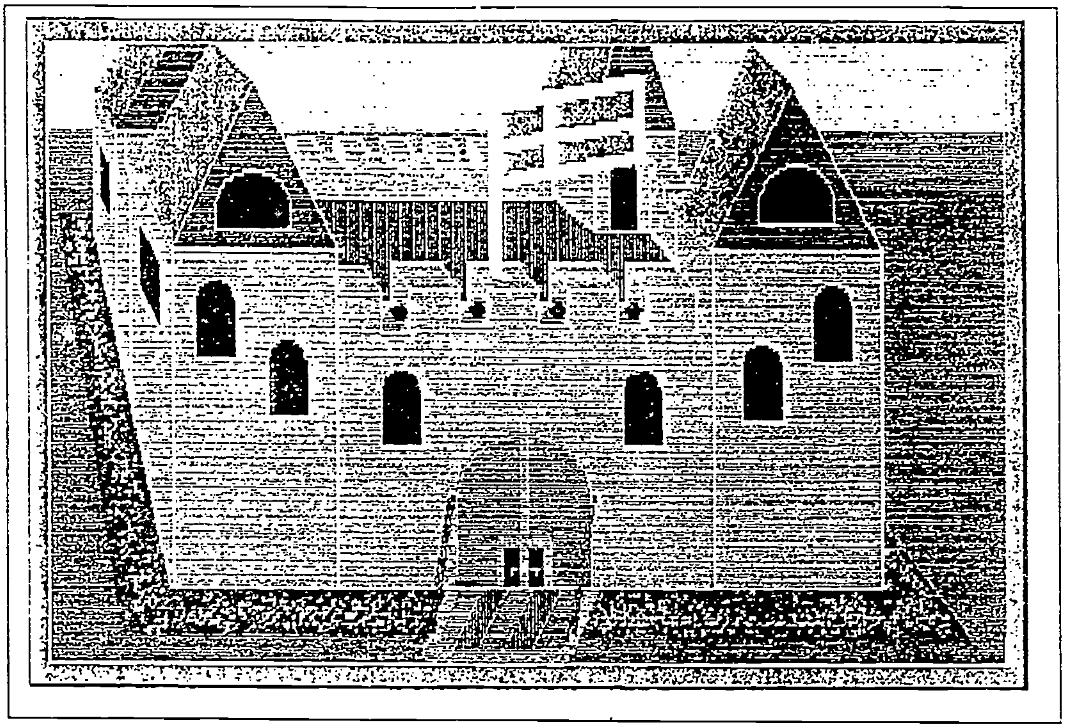
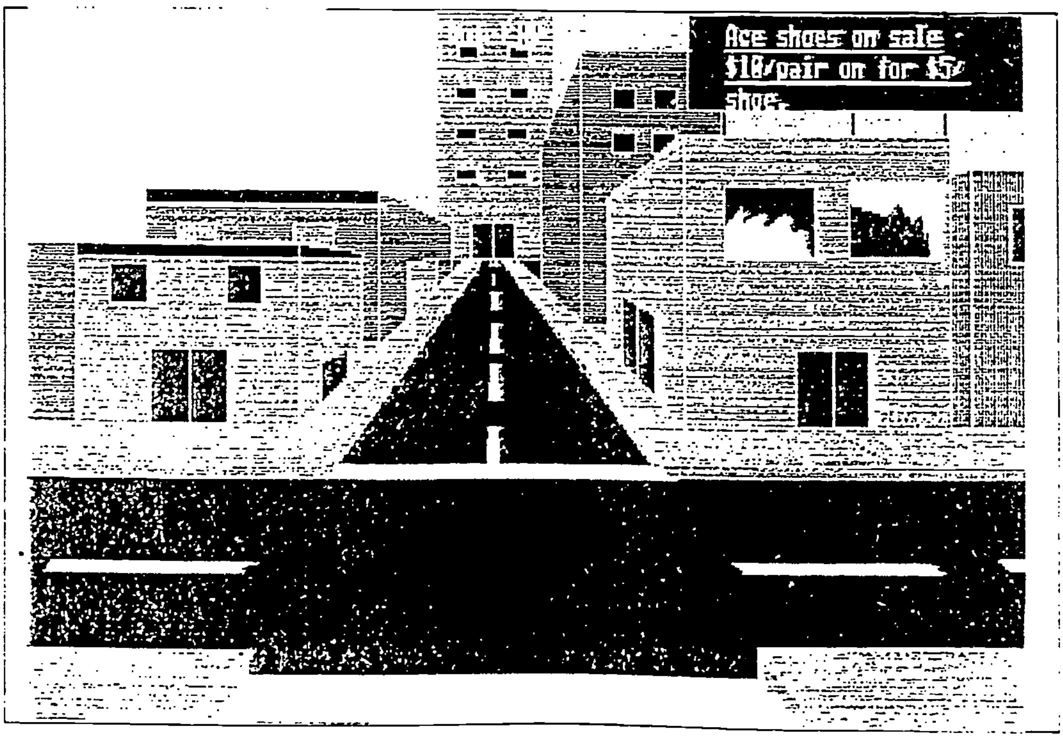


Figure 2.8: Perspective Drawing



Two themes surfaced repeatedly during the reflection time: the concept of *play* within learning/creativity; and, the nature of student supervision during computer periods. As for the former, both practitioners felt that students needed to play with the computers before beginning to engage in ordered studio work. The comparison was made with more traditional methods of producing *rough work* in art, such as sketching and modelling. The importance of play in terms of its role in general learning has been promoted for many years by Courtney (1980; 1982); May (1975) has suggested that many qualities of play, such as the temporary suspension of physical realities and judgements, are necessary precursors to creative expression.

The art teachers discussed several aspects of the supervision of students during computer classes. Wendy Farnham said that she was often forced to leave some students unsupervised in the studio while she was helping others in the computer laboratory at Brock (which is not even on the same floor of the building). Barb Cunningham felt that it was easier to keep students *on task* when only three parallel computers were involved than when a whole class was working in a laboratory situation. She added, however, that she had to keep repeating information as each trio of students began their computer periods according to the class schedule.

By the conclusion of the second research semester, the art project had been professionally implemented at both school sites. Few alterations appeared to be necessary at that point in time. Credit for the remarkably smooth implementation process had to be assigned to two key groups:

a. the cooperating teachers, both of whom had given a heightened dimension to the term *cooperating*; and,
b. the RUCCUS Research Officers, whose individual and collective expertise had enriched the project-at-large from Day One.

2.2.6 RESEARCH COMPLETED: IMPLEMENTATION BLOCK 3 Second Semester, 1989/90 School Year

2.2.6.1 Consolidation of Data Collection Techniques

During the third implementation block, the techniques employed by the RUCCUS research team remained essentially identical to those utilized during the first semester of the 1989/90 school year. Up to this point, the researchers had been gradually refining several data collection strategies that involved both in-house and on-site issues. For example, the degree to which the RUCCUS Research Officers interacted with students at Brock and Tecumseh posed numerous contextual dilemmas whose resolutions evolved over time; time which allowed the Research Officers the opportunity to deliberate among themselves, consult with the cooperating practitioners, and test various approaches on-site.

As well, by the start of the third implementation block, the board liaison had completed the acquisition and installation of computer software/hardware at Brock and Tecumseh, thus allowing observation of the final configuration. The collection of field data related to the CD-ROM units housed at each school site library, for example, had only recently become available.

The consolidation of data collection strategies had not been limited, however, to the operational sphere of the RUCCUS Research Officers. Each Principal Investigator had also needed to analyze his professional contacts with the cooperating practitioners at the end of each implementation block and ascertain whether or not changes appeared to be warranted.

It seems advisable at this point, therefore, to discuss the theoretic and operational structures that characterized the professional relationships between this Principal Investigator and the cooperating art teachers.

The research strategies used within the art project were founded upon two qualitative perspectives:

a. a reliance upon the cooperating teachers as *key informants* within a Grounded Theory framework (Glaser and Strauss, 1967); and,
b. a conceptualization of teaching as an inquiry-driven, reflective practice (Schön, 1983; 1987).

These two qualitative perspectives, in turn, spawned two fundamental research principles that guided my interactions with the classroom teachers involved with the art project. First of all, I consistently viewed the cooperating practitioners as research colleagues, capable of practice-grounded, independent action. Secondly, I firmly believed that the tacit knowledge of a competent classroom teacher was capable of providing its own pedagogic response to a pre-determined research framework.

As described in *Interim Report #1*, a research framework for the art project was determined prior to the assignment of any cooperating practitioners by the participating board of education. The fundamental aspects of Grounded Theory research were discussed and some potential outcomes for the art project were offered. The pedagogic responses required to implement such skeletal research objectives, however, were not provided (let alone prescribed) by the Principal Investigator. It was assumed that each classroom teacher would want, and would be able, to provide implementation strategies suited to local conditions.

This empowerment of the cooperating practitioners to implement site-specific pedagogic strategies allowed me, as the Principal Investigator, to develop a distanced, indirect and primarily supervisory role. Such a posture was balanced and maintained, however, through the early establishment of a high level of trust and collegial rapport among the two classroom teachers and myself. The cooperating practitioners accepted the challenges presented, I believe, for two fundamental reasons:

a. they viewed such challenges as an opportunity to expand their professional knowledge and skills; and,
b. they understood that a *safety* network was available to them, should they have required assistance. This network was made up of many individuals, of which the Principal Investigator was but one.

Another key factor in the moulding of my role as principal investigator was the RUCCUS research team. The profoundly professional work provided by the two Research Officers, as well as the mentoring assistance offered by the Project Coordinator, Dr. Ivor Goodson, complemented and facilitated my research strategies from the start. They afforded me the same level of collegial respect and the empowerment to act independently that I tried to foster in my work with the cooperating teachers.

Although one more implementation block remained to be undertaken, I felt it was possible to state with some justification that the research postures taken within the art project had been fruitful. The two cooperating practitioners remained solidly *on board* and committed to the project. Indeed, their enthusiasm and perseverance had never been in doubt. *No toes had been stepped on*, either at the school sites or at the RUCCUS office. The remarkably smooth progress of the art project bode well for future research undertakings among Ministry, faculty, and board personnel.

2.2.6.2 Special Events During Block 3

Two special events related to the project-at-large occurred during the third implementation block. On February 21, 1990 a full-day meeting was held at Spencer Hall in London. In attendance were almost all of the cooperating practitioners, the RUCCUS Research Officers, the Principal Investigators, and the board computer liaison. The assembled group was given progress-to-date reports (prepared by the appropriate Principal Investigators) on the two across-the-board projects: Spreadsheets and Administrative Applications. The remainder of the morning was spent in small, group sessions designed to provide open-ended discussions related to each of the subject-based projects: art, social studies, and technological studies. After luncheon, Dr. Goodson outlined some specifics behind the research strategies employed thus far and fielded questions from the cooperating practitioners. Both of the art teachers spoke highly of the Spencer Hall meeting and felt that the time was well spent. Barb Cunningham, the cooperating teacher from Tecumseh, did suggest, however, that the skeletal nature of the proposed agenda made it difficult for her to be as prepared for the day's events as she would like to have been.

The second special event occurred on April 25, 26, and 27, 1990. The cooperating teachers, the board computer liaison, and the RUCCUS Research Officers attended a provincial conference sponsored by the Educational Computing Organization of Ontario (ECOO). Again, both of the art teachers spoke highly of the conference and its value to them as research colleagues. The art teachers appreciated the opportunities for further exposure to the array of new computer software and hardware available to educators here in Ontario. Barb Cunningham asked Santa Claus for a computer scanner and *Corel Draw* software package.

2.2.7 **RESEARCH COMPLETED: IMPLEMENTATION BLOCK 4**

First Semester, 1990/91 School Year

2.2.7.1 CAL Curricula Revisited

The first semester of the 1990/91 school year marked the final episode of data collection for the project-at-large. Perhaps the most interesting aspect of the analyzed data was the fact that most of the CAL curricula developed and implemented at the start of the project by the cooperating art practitioners remained in service. A review of the major curricular packages originally developed by the teachers in the art-based project would seem to be warranted at this time; as well, re-statement of the contextual relationships between the various curricular elements and the CAL terminology outlined at the outset of this report would probably be helpful.

Computer activities which occurred at the two research sites during the final implementation block can be listed within the functional typology of learner/CAL interactions developed by UNCAL (Kemmis, Atkin, and Wright, 1977):

a. **Recognition tasks** *often involve yes-or-no types of learner responses. No comprehension levels are determined through these kinds of interactions.*

No examples of art-based CAL curricula within this UNCAL category were observed.

b. **Recall tasks** *typically require fill-in-the-blank kinds of responses. Again, no levels of comprehension are involved although the assimilation and/or memorization of content can be addressed.*

No examples of art-based CAL curricula within this UNCAL category were observed.

c. **Reconstructive Understanding tasks** *usually are of the multiple-choice variety. Student comprehension of program content within this category can be assessed through processes requiring semantic manipulation.*

No examples of art-based CAL curricula within this UNCAL category were observed.

d. **Global Reconstructive tasks** *often relate to learner-directed interaction processes. Student responses in this category are open-ended; their assessment involves not only the correct application of program content but extension requiring analytic, synthetic, and creative solutions.*
   Examples of art-based CAL curricula within this UNCAL category were observed at both sites. At Tecumseh, the Grade 9 classes were assigned computer-generated colour wheels; the Grade 11 students were asked to produce Egyptian cartouches. At Brock, students generated package wrapping through the repetition of computer clip-art images; they also produced texts for a variety of graphic applications.

e. **Constructive Understanding tasks** *are even more open-ended than those involved in Global Reconstruction. Here, original knowledge or constructions are required; they are assessed relative to their application to relevant functional frameworks.*
   Examples of art-based CAL curricula within this UNCAL category were observed at both sites; in fact, the vast majority of the CAL curricula fell into this category. At Tecumseh, the Grade 9 classes had two such assignments: a perspective project (involving 1- or 2-point linear perspective, or atmospheric perspective) and a free choice project. At Brock, the art students were asked to generate personal illuminated scripts.

Another research objective of this project was to investigate art-based CAL within the four curricular paradigms developed by MacDonald, Atkin, Jenkins, and Kemmis (1977). As done previously with the UNCAL typology of learner/CAL interactions, the analyzed data collected during the fourth implementation block can be discussed within the MacDonald *et al.* taxonomic model of cognitive activities.

a. **Instruction CAL,** *involving drill, practice, and tutorial activities*:
   At both Brock and Tecumseh, Instruction CAL activities were limited to brief, teacher-lead demonstrations, usually used to introduce students to computer rudiments, such as login procedures. Drill and practice exercises were virtually non-existent. Students at both school sites made little use of the instructional opportunities afforded by the *Art Treasures* software package; few art students were observed using the *Grolier Encyclopedia* software on the CD-ROM installation. Tutorial activities, however, were frequently observed. They usually involved peer-based Instructional CAL. Both cooperating practitioners typically utilized *coaching* strategies during teacher-based tutorials.

b. **Revelatory CAL,** *utilizing simulations and trial-and-error exercises*:
   Both students and teachers stressed the importance of *play* opportunities directly after teacher-lead Instructional CAL episodes. Revelatory activities were frequently compared to the production of *rough work* in more traditional studio processes. Students engaged in Revelatory CAL were repeatedly observed interacting with peers in brief Instructional CAL sessions before returning to their own experimentations. It should be stressed that

art-based CAL activities do not follow a linear progression; students move back and forth with great regularity among the three cognitive levels of Instructional, Revelatory, and Conjectural CAL. It was interesting to note that the two cooperating art practitioners expressed their hope that future teacher-training sessions conducted by board liaison personnel would follow similar pedagogic strategies (brief liaison-lead introduction and substantial blocks of time for personal experimentation).

c. **Conjectural CAL,** *relating to the creation of new knowledge*:
The majority of observed cognitive CAL activities fell into this category. Given the emphasis placed upon creativity within art as a school discipline, this conclusion was not surprising; in fact, such results were predicted in *Interim Report #1* (Clark, 1989, p. 51). But the two cooperating practitioners had somewhat differing attitudes concerning Conjectural CAL activities and related curricula. At Brock, Wendy Farnham spoke of the need for her Graphics students to do their creative experimentation **prior** to working directly on the computers. She felt that the ease with which colours, layouts, and texts were manipulated by the computer encouraged students to consider far too many design options; such time expenditures would not be tolerated in commercial work settings. On the other hand Barb Cunningham, at Tecumseh, was troubled by CAL projects that involved limited amounts of Conjectural cognition. She questioned the artistic value of projects that involved computers merely as production *tools*. Her visual arts curricula favoured media, such as watercolour, that facilitated a full sequence of creative processes and involved direct student manipulation of media.

d. **Emancipatory CAL,** *encompassing activities that free individuals from routine, time-consuming tasks*:
Both cooperating practitioners used their computers in the preparation of curricular documents. Barb Cunningham used *Write* for memos/letters and *Spectricon* for student handouts. Wendy Farnham used only her Mac computer for the preparation of memos, examinations, handouts, and purchase orders. Neither teacher used their computer facilities for marking purposes. Reasons given for this included: the three-dimensionality of artwork, the intermittent nature of teacher time related to marking, and the low need for complex mathematical computations.

2.2.8 SATURATED EMERGENT CATEGORIES

By the completion of the fourth block of CAL implementation, each of the original five emergent categories remained viable: **student backgrounds**, **teacher profiles**, **classroom environments**, **classroom dynamics**, and **curricular structures**. The series of emergent categories proved to be remarkably useful for the classification, entry, and analysis of data; there was no need to add, delete, or merge categories. It was noted that some of the categories played more prominent roles than others; for example, the generic category **classroom dynamics** received far less data than the others. The *quantity* of data entries was not, however, the primary factor. The *frequency* with which data entries reappeared was more important, especially when summative analyses of each category were conducted.

According to Grounded Theory (Glaser and Strauss, 1967), the collection of data should continue only as long as new entries are routinely being added to specific categories. When new data only repeat previous entries, a condition of category *saturation* is said to have been reached.

By the end of the final CAL implementation block, all five emergent categories had reached a level of data saturation.

The research findings in each emergent category have been classified by frequency of observation:

a. **data entries with a HIGH FREQUENCY of observation have been printed in bold type;**
b. data entries with a MODERATE FREQUENCY of observation have been printed in normal type; and,
c. *data entries with a LOW FREQUENCY of observation have been printed in italicized type.*

2.2.8.1 Student Backgrounds **(Data Group A)**

A1 Previous keyboarding experience appears to have little direct value in the context of computer graphic software.

A2 Most students in the study recall working with rudimentary computers, such as Commodore 64s, when pupils in Grades 7 or 8 or in the home environment. These earlier exposures to CAL seem to have little carry-over value since the students refer to such episodes as *play* activities. The distinction between play and *real* school assignments often revolves around the element of marks.

A3 Student attitudes towards computer art usually improve in direct proportion to the attainment of computer proficiencies.

A4 The students rarely mention any gender-related issues in discussions with the research team. When pressed, however, they *think* that students oriented towards subjects such as Mathematics and Science would be more drawn to computer art.

A5 Many students report that they have made use of the computers located in the Library at both school sites. Usage is either for *play* computer activities or for access time not available through classroom/lab facilities.

A6 Many students believe that art *mistakes* are easier to *correct* on computer screens than on more traditional art surfaces, such as paper or canvas.

A7 Students with identified learning disabilities in academic subjects, such as English, often demonstrate considerable skill within the area of computer graphics.

A8 Areas of student interest within the field of art often colour student attitudes toward the role they expect that computers will play in their future art careers. For example, students who anticipated employment as graphic illustrators made a distinction between generating images for advertising layouts and for children's books. In the former case, computer proficiencies were expected to be of considerable value due to the computer's ability to produce vivid hues, geometric shapes, and textual material. Illustrations for children's books, on the other hand, were expected to be produced manually with watercolours being the likely medium.

2.2.8.2 Teacher Profiles **(Data Group B)**

COMMONALITIES between the cooperating practitioners:

B1 rely upon indirect pedagogic approaches in studio classes

B2 employ democratic principles in class whenever possible
B3 encourage student ownership/responsibility throughout projects
B4 foster positive attitudes and self-confidence in students
B5 view teaching as more than the transmission of knowledge
B6 use computers for the preparation of curricular materials
B7 rarely use computers for administrative tasks
B8 have retained enthusiasm for the project by expanding their computer knowledge/skills and revising previous curricula
B9 report that the amount of preparation time required for computer art is reduced as experience/practice increases
B10 have not removed any content from existing art curricula to accommodate computer assignments. This has been accomplished by using the computer as a medium wherever possible in existing units of study
B11 have not altered their pedagogic routines during computer art classes
B12 consider the computer primarily as an artistic medium rather than as a pedagogic device
B13 participated actively in school sports as students and continue to do so as teachers
B14 travelled extensively with their families during youth
B15 identified as dyslexic when students in high school
B16 employed in commercial art prior to teaching secondary school

DISTINCTIONS between the cooperating practitioners:
B17 Barb Cunningham (Tecumseh) is teaching visual arts (academic); Wendy Farnham (Brock) is teaching graphic arts (vocational)
B18 age spread of approximately ten years
B19 marital status
B20 Wendy Farnham has made extensive use of the *Art Treasures* computer program within an art history course segment.
B21 Wendy Farnham has encountered some resistance from colleagues during her implementation of computer art at Brock. The reasons for the resistance are varied; most stem from philosophic positions related to the proper role of computers within art.
B22 Barb Cunningham has applied for, and been awarded, a study leave from the board of education. The study will involve computer applications within the field of printmaking

2.2.8.3 Classroom Environments (Data Group C)

COMMONALITIES between the two school environments:
C1 Rotation/booking schedules are not rigidly enforced.
C2 Students are often reluctant to leave computer areas at the end of class time.
C3 Both teachers believe that a combination of lab/class computer facilities within schools is advisable.
C4 Both teachers contend that a computer technician needs to be on-site on a regular basis. Such technical assistance is not required full-time, especially after the first

year of CAL implementation. When such assistance is requested, however, a speedy response is essential.

C5 Wall displays within classrooms are dynamic and frequently changed. Such visual elements were seldom seen elsewhere in the two research schools.

C6 Music is prevalent during both studio and computer classes.

C7 Students discuss school and personal issues during classes.

Items relevant to the computer laboratory at **BROCK:**

C8 Wendy Farnham finds teaching in the computer laboratory *easier* compared with the studio because she has less need to circulate and because the students are more frequently *on-task*.

C9 The students are rarely distracted when other students or teachers work in the computer laboratory during art classes.

C10 The physical distance between the laboratory and the art room is excessive and places unacceptable limits upon Wendy Farnham's implementation of curriculum and supervision of students.

Items relevant to the studio-based computers at **TECUMSEH:**

C11 Having only 3 computers in her studio has made Barb Cunningham reluctant to make her computer art assignments compulsory.

C12 Public displays of computer art were repeatedly seen during visits to Tecumseh.

C13 Barb Cunningham would like to have a larger computer room at Tecumseh; she would prefer to continue having it separate from the main studio area in order to reduce the number of students entering the computer area to *talk* with classmates.

C14 The glass partition separating the computer area from the art studio makes it easier for students to get Barb Cunningham's attention at any given time.

C15 Ideally, Barb Cunningham would like to see art studios in which each student has a "pop-up" computer at his/her desk.

2.2.8.4 Classroom Dynamics (Data Group D)

D1 Numerous episodes of peer teaching were noted during this semester.

D2 Teachers typically asked their students to solve design problems themselves through self-examination and the application of generic problem-solving techniques.

D3 Both cooperating practitioners saw their primary pedagogic style as one of *coaching* (this is not always the case in art classes; many teachers adopt the *master artist* approach).

D4 The teachers often displayed unusually high thresholds of professional tolerance in the following curricular areas identified by Courtney (1980): noise; space; size of group; decision-making; teacher interests; evaluation and standards; and, role.

D5 art students are characterized as being more diligent and *on task* in their computer studies than in studio assignments.

D6 Peer (student) teaching sometimes extends into shared work on computer art assignments.

D7 Both teachers frequently mentioned that they "learn a lot from the students" and derive much pleasure as educators from assisting their students in the realm of social development.

D8 Student self-evaluation processes were used extensively. Final grades were often the result of student/teacher conferencing.

D9 Mistakes made by the teachers during demonstration lessons were readily accepted by the students. The creative process appeared to be understood by the students as a series of tentative steps mingled with occasional setbacks. Perfection was expected from neither students nor teachers. For example, a male student was convinced by Barb Cunningham to print out a "crashed" image in order to investigate non-objective form.

2.2.8.5 Curricular Structures **(Data Group E)**

Items related primarily to **HARDWARE/SOFTWARE:**

E1 Students at Tecumseh worked with *Co-Co* and *Curriculum Crosswords* as well as *Spectricon*, *Draw*, and *Ipaint*.

E2 Students at Brock worked with *Co-Co*, *Curriculum Crosswords* and *Show'n Tell*, as well as *Spectricon*.

E3 Art history students at Brock made extensive use of the *Art Treasures* software package. The students at Tecumseh did **NOT** make much use of the *Art Treasures* package because it is not chronologically sequenced.

E4 Some cursor problems were still surfacing in *Spectricon*.

E5 The relatively short lifespan of the colour printer ink cartridges and the need/cost to replace them frequently are important issues in computer art classes.

E6 The need for a site technician was stressed by both teachers.

E7 System *crashes* became less frequent at both school sites as the project progressed.

E8 Several students reported colour alterations while *saving* their work. As a result, print copies frequently reversed areas of red and orange.

E9 It was suggested that the **perspective feature** within *Spectricon* was responsible for repeated crashes both sites.

E10 The students at Brock found the text-producing capabilities of the ICON computers too limited; as a result, they relied on *Pagemaker* on the Brock Mac computer for the generation of text for layout paste-ups.

E11 Students and teachers often became bored with the limitations of *Spectricon* after a moderate degree of proficiency was obtained.

E12 Many students declared preferences for the ICON trackball over the Mac mouse.

E13 Several students described computer-generated art as *easier* to produce than manually-produced art.

E14 Barb Cunningham reported more frequent login difficulties with the revised version of Spectricon.

E15 Some student work was lost during hard disk clean-ups at Tecumseh.

E16 *Students at both schools found the user commands embedded within Ipaint too restrictive; many reported greater creative potentials with the less text-controlled Spectricon*

E17 *Some students found the limited screen image of the Mac computer frustrating; conversely, the full screen image of the ICON system was considered to be beneficial.*

E18 *The absence of visuals within the Grolier Encyclopedia software package was cited as an explanation for why so few art students used the CD-ROM units in the site libraries.*

E19 *The ICON system was criticized for its inability to prepare students for DOS computer systems. Students and teachers, however, acknowledged the relative benefits of all systems.*

E20 *Both teachers spoke of the need to keep up-to-date with new computer technologies. The time requirements implicit in this regard were stressed.*

E21 *Barb Cunningham found the colour prints to be too small for display purposes. To partially compensate for this situation, she made 11"x14" colour xerox copies of work destined for display.*

E22 *Barb Cunningham would like to obtain: a scanner, Corel Draw software, and an art history computer package organized upon a chronological presentation format.*

Items related to general **CURRICULAR ISSUES:**

E23 Virtually all students reacted positively to the computer assignments at both research schools. Barb Cunningham felt that most examples of student computer anxiety could be directly related to low levels of student self-confidence.

E24 The teachers reported that they usually *re-worked* existing lesson plans so that they could involve the computers. This was necessary because of the extensive courses of study already mandated at each school. If such curricular merges were not possible, the regular courses of study were given priority over computer assignments. The need for teacher flexibility in such situations was stressed.

E25 The cooperating teachers usually left the choice of subject matter up to their students. This resulted in predictable thematic content with stereotypical elements related to age and gender.

E26 The teachers did not penalize students for computer accidents, such as *lost* work. That made it easier for students to cope with system crashes, improperly stored graphics, printer problems, *et cetera*. The teachers were able to grade lost or damaged computer graphics because they regularly circulated among the computer facilities and could recall earlier stages of student work.

E27 A few students at Brock learned how to transfer some *clip Art* graphics into *Art Treasures*, thus avoiding the computer drawing element of the art history assignment. Wendy Farnham was undisturbed by this activity since "many of the kids don't draw well" and she felt that the primary goals of *Art Treasures* were more important than the computer imaging task.

E28 Male students appeared to be preoccupied with producing exact images. This involved extensive usage of the magnifying function.

E29 The evaluation processes used by the two teachers differed significantly in that Barb Cunningham graded student work *while on the monitor* and Wendy Farnham marked *colour print copies.*

E30 As a consequence of the previous data entry (#7), the students at Tecumseh did not *expect* to take home print copies of their computer graphics; they remained satisfied with the more intangible monitor images. This situation was reversed at Brock perhaps because the print copies were often used as part of subsequent studio applications, such as package wrapping, layout paste-ups, and so on.

E31 Students and teachers alike felt that the creative process could be enhanced through the computer generation of visual images. The creative process was felt to be accelerated, more spontaneous (instant feedback), and more in-depth (more options available).

E32 Barb Cunningham reported that, as the project progressed, she introduced the computer techniques less sequentially and encouraged more student exploration/experimentation.

E33 Students at Brock and their teacher, Wendy Farnham, lamented the fact that the speed of computers had not reduced employee stress in the workplace; conversely, it had increased stress levels because work loads had grown at the same pace.

E34 At Tecumseh, Barb Cunningham was concerned about the cost-effectiveness of CAL activities.

E35 Barb Cunningham voiced her belief that computers will NOT transform teaching/learning, especially in experience-based disciplines, such as art. The distanced, non-hands-on characteristic of computer imaging made her question the artistic validity of CAL activities.

2.2.9 DISCUSSION OF EMERGENT ISSUES

2.2.9.1 The Perceived Need for Computer Literacy

A recurring theme, found throughout the data collected, centred around the widespread social consensus that a measure of **computer literacy** would be required of most members of our future work force. Many of the students interviewed in this study felt that the implementation of art-based CAL activities in their school better prepared them for future employment; furthermore, many were resigned to the *inevitability* of a computer-dominated tomorrow.

Many of the assumptions embedded in the clarion call for mass computer literacy, so successfully trumpeted in the past decade by individuals within mass media and computer corporations, have not been rigorously scrutinized by many educational researchers. Noble (1984), however, has suggested that the need for computer literacy in the so-called *information age* has been grossly exaggerated by profit-driven *corporate boosterism* and shallow *science journalism*:

a. computer literacy will not be needed by future consumers because home computers will become increasingly *user friendly*; repairs and maintenance of home computers will be undertaken by specialists, just as consumers currently rely upon auto mechanics, plumbers, electricians, and so forth;

b. the need for student literacy in the near future will be substantially less than predicted by computer advocates due to the "Kitty Hawk" state of current hardware, small pool of trained teachers, limited funding, and inadequate software;

c. as for worker literacy, "only 7 percent of the new work force will involve high-tech positions for programmers, technicians, computer operators, and engineers, and any current shortages in these areas will soon be filled" (Levin and Rumberger, 1983, p.5); as well, the evolution of high technology has traditionally required **less-skilled** personnel, not more highly-skilled employees; and,

d. citizens have rarely (if ever?) been democratically consulted on technological issues and the lack of social responsibility seen in **computer boosterism** thus far (for example, the lack of concern expressed by governments at the possible employment disenfranchisement of the poor, computer-illiterate) is not encouraging.

It was noted that a few students mentioned in their interviews that they were afraid to ignore the challenges of CAL assignments for fear of reduced employment potentials. The plight of the computer illiterate and the underclass of marginal employees that the institutionalization of computer literacy threatens to create are issues that have recently emerged in educational literature. Practitioners considering the implementation of art-based CAL need to consider this potential for social discrimination, as well as the broader question of how truly **necessary** computer literacy will be for tomorrow's work force:

> Avoided, of course, is even a cursory examination of whether computer literacy represents a basic skill so profoundly important as to justify the multibillion dollar public programs required to promote it. The real social equity tragedy is that one more racial and class barrier is being erected without any justification and in the complete absence of public debate. (Menosky, 1984, p. 618)

2.2.9.2 <u>Pedagogic Resistance to CAL</u>

Educational practitioners confronted with the introduction of computer-based CAL are subjected to many challenges presented by emergent technologies. Once the decision has been taken to accept computers into their classrooms, contemporary art educators, like artists throughout history, have to adapt their craft to accommodate new ideas and innovative pedagogic techniques.

The degree to which change agents, such as computers, are resisted by practitioners can be dependent upon several pedagogic conceptions, which include: **professional thresholds of security**; **practitioner roles**; and, **personal commitment to current practices**.

In the first instance, computer-based art activities may be actively resisted by educators if professional thresholds of security are exceeded. Courtney (1980), in his text *The Dramatic Curriculum*, cites seven such thresholds originally listed by noted British Drama specialist Dorothy Heathcote: **noise, space, size of (teaching) group, decision-making, teacher interests, evaluation and standards**, and **role**. Should a computer-based art activity require changes so massive that teacher security is threatened within any one or more of these pedagogic categories, active teacher resistance is likely to be observed.

The last threshold of security, **practitioner role**, can often prove to be a pivotal factor. As is the case in many disciplines, art curricula vary considerably both in content and intent. The attendant pedagogic implications of such curricular diversity produce a variety of teacher roles. ***Art-as-product*** curricular models often place educators in the role of **master artist** or **art historian.** Direct modes of instruction, lectures and skill demonstrations, *et cetera*, which offer efficient methods of knowledge transmission, further reinforce such teacher-centred practitioner roles. ***Art-as-process*** curricular models, on the other hand, place educators in the role of **coach** or **facilitator.** Indirect modes of instruction, such as discussion, self- or peer-evaluation, and so forth, reinforce such student-centred practitioner roles. Art curricula that present a balanced emphasis between product and process require educators to employ both direct and indirect modes of instruction. Sometimes the art teacher is seen as the primary source of knowledge; at other times, *answers* to artistic problems are sought from peers or from self. Teachers working within balanced art curricula must be adept at listening as well as telling, supporting as well as assessing.

The introduction of CAL art activities often poses threats to the security of educators accustomed to teacher-centred practitioner roles. Many such teachers feel uneasy admitting to students that they are not computer experts. Others find the notion of *computers as an art medium* incompatible with traditional Fine arts curricula. Still other educators are unsettled by the discovery that computer monitors focus student attention away from *the front of the room* and *the teacher*.

Educators accustomed to student-centred practitioner roles are not immune from role anxieties, either. Student interactions with computers often involve non-verbal, stationary, and solitary student activities; such characteristics may be viewed as counter-productive to the social- and self-development of students and, therefore, not conducive to process-based art curricula. As well, students often require periods of explicit instruction, drill, and practice in order to gain rudimentary command of computer operation. These three types of classroom activity may cause difficulty for many proponents of art-as-process because such activities place significant degrees of emphasis upon left-hemisphere cognition and the completion of *correct* products.

The acceptance of computer-based art activities is less stressful to educators accustomed to a variety of practitioner roles. Such teachers are often comfortable introducing computer assignments when their own level of computer literacy is marginal. Likewise, the concept of *computer as media* is more acceptable to art teachers capable of appreciating the importance of left- and right-brain cognition, process and product. In addition, such teachers are traditionally adept at providing skill demonstrations for the class-as-a-whole; offering encouragement to individuals while circulating among the computer stations; and encouraging the development of unique artistic solutions after the completion of adequate drill and practice sessions.

Personal commitment to current practices also plays an important role in the acceptance of CAL activities. The degree to which practitioners are committed to particular philosophies of art education will affect their willingness to accept and incorporate new ideas. Roueche (1979) has constructed a continuum along which various degrees of *resistance to change* have been placed. Personal **beliefs** are given as the most resistant to change, followed (in order of decreasing resistance) by: **values, prejudices, attitudes, and preferences.**

Practitioners may be committed to their current practices at any point along this resistance to change continuum. Such commitments may be assessed in relation to overall practice or within the context of constituent elements, such as media, subject matter, evaluation, and so on. As well, degrees of practitioner commitment vary widely among those espousing art-as-product, art-as-process, and everything in-between.

Proponents of educational change, such as computer enthusiasts, need to gauge the degree of practitioner commitment to current practices and employ appropriate strategies to reduce levels of resistance. Roueche suggests that the following approaches are useful in lowering resistance to change: **use of authority**, **role-playing**, **cognitive dissonance**, **social learning**, and **identification/modelling.**

2.2.9.3 <u>Cost and Effectiveness of CAL</u>

Major impediments to any educational reform are increased costs and the introduction of computer-based art activities most certainly requires substantial financial commitments. Given the obvious cost factors involved, it is surprising to discover how infrequently researchers have attempted to ascertain just *how expensive computer instruction actually is.*

A recent article by Levin and Meister (1986) entitled, "Is CAI cost-effective?" attempted to discuss the start-up and maintenance costs related to school computer usage, and to compare the effectiveness of CAI with three alternate educational interventions.

According to Levin and Meister, approximately 90% of CAL costs are associated with personnel, software, training, and other non-hardware factors. Their calculations suggest that the cost of CAL is unlikely to be significantly reduced in the future. The cost of microcomputers fell sharply during the 1980s, however, even if further price reductions occur during the current decade, the savings will affect only a small portion of the overall CAL costs.

Administrators contemplating the installation of computers in schools need to be cognizant of two budgetary realities: the initial year of CAL will require significant funds for the training of site personnel and classroom teachers; and, cost estimates for subsequent years should include substantial maintenance costs, including the regular repair of hardware and the salaries of site personnel. The financial calculations related to the initial purchase of hardware should take into account the number of students using the computers and the total number of years that the equipment is expected to be in operation.

Levin and Meister attempted to provide concrete figures related to the cost of CAL; needless to say, their efforts at specificity lead to an immediate critique of their calculations (Niemiec, Blackwell, and Walberg, 1986) and demonstrated clearly the difficulty of providing generalizable conclusions. For example, Levin and Meister estimated 1984 teacher salaries at $25,000 *per annum*; this cost estimate, crucial to all subsequent calculations and analyses, would hardly have reflected actual teacher salaries in Ontario in 1974, let alone 1984.

Nonetheless, Levin and Meister soldiered on and attempted to compare the cost effectiveness of CAL with three alternate pedagogic interventions: **cross-age tutoring**, **reduced class size**, and **a longer school day**. Comparisons were conducted to determine levels of improvement within Mathematics and Reading achievement at the elementary school level. In terms of *learning effectiveness*, Levin and Meister concluded:

> The CAL intervention produced a healthy result, with more than a month of student gain in Mathematics and more than two months in Reading, for a 10-minute daily session in each subject. Even larger effects were found for peer tutoring, however, with a gain of almost one full year in Mathematics achievement and almost half a year in Reading achievement. By contrast, reducing class size showed less than a month of gain in both

Reading and Mathematics for each five-student decrement. A direct reduction from 35 to 20 students, however, was associated with gains similar to those for CAL, but with subject areas reversed. Finally, the addition of half hour per day of instruction in each subject yielded very small gains. (pp. 748-749)

Within the context of cost-effectiveness Levin and Meister's study produced mixed results, indicating that CAL was more cost-effective than adult tutoring, reducing class size, or increasing instructional time; noticeably less cost-effective than peer tutoring in Mathematics; and slightly less cost-effective than peer tutoring in Reading.

2.2.9.4 <u>CAL, Metacognition, and Collateral Learning</u>

The overall *effectiveness* of CAL cannot be determined, however, through the analyses of narrow curricular phenomena or financial calculations. The introduction of computer-based art activities has implications for **metacognition** and **collateral learnings**; in other words, the *side-effectiveness* of CAL needs to be considered alongside the more readily visible signs of increased student achievement.

Many concerns about the harmful side effects of CAL relate to the development of curriculum for young children. Cuffaro (1984) questioned the common assertions that computers: motivate youngsters; provide immediate feedback; facilitate individualized learning; and, encourage social interaction. She cited instead the collateral effects:

> It is the presence of these collateral learnings—the distancing and narrowing of physical reality, the magical quality of pressing keys, the "invisible" sharing of control, the oversimplification of process, the need for precision and timing—that merit great attention when thinking about young children's learning and the use of microcomputers. (Cuffaro, 1984, p. 561)

Cuffaro panned CAL for its **passive nature** and exhorted educators to provide large-muscle, full-bodied play activities for young learners. She didn't appear, however, to have had much experience with computer graphic software. In a lengthy section praising the ability of liquid paint to spill, blend, and smell, Cuffaro implied that graphic software could replicate none of these experiential *highlights*; in reality, even the most rudimentary paint software packages can replicate spillage and blending. Can one doubt that the development of *smelly* software is far off?

Another forceful criticism of CAL, again related to child development, involves the ability of computer-based simulations to adequately provide "**aesthetic and ethical dimensions** of the psyche":

> The cultivation of a balanced life of feelings depends on an environment in which the use of colour, form, materials, song, all unite to create a surround that fills the child with a lively experience of the beautiful. (Zajonc, 1984, p. 572)

Zajonc expressed concern not that computers will replace the teacher but that computers will replace the child:

> The computer is like a fragmented projection of the human psyche. Each of its functions replaces one of our own. Just as we have replaced the child's active imagination (that is, the exercise of assimilation) through television imagery and certain toys, so the computer has the potential to replace nearly all the mental functions of the child. (p. 575)

The introduction of formal operations (in the Piagetian sense) into the early periods of child development through computer-based school activities threatens to lessen opportunities for children to develop emotional and moral capacities. Zajonc suggested that educators follow the tenets of Waldorf pedagogy which stress that the learning of represented and abstract operations must be based in action.

The similarities between the viewing of television screens and computer monitors are obvious and, just as educators have long predicted dire consequences from the many hours that children spend in front of television sets, the exposure of young children to CAL has also raised pedagogic concerns. Greenfield (1984; 1990) investigated video-based media (film, television, and computers) and found that such media produce the following cognitive benefits:

a. a wide range of visual literacy and iconic decoding skills;
b. superior acquisition levels of knowledge, in general; and,
c. better acquisition of *action information*, in particular.

On the other hand, the same study indicated that video-based media lead to the following decreases in cognitive development:

a. reduced stimulation of pupil imagination;
b. a reduction in the amount of mental effort expended; and,
c. less attention paid to purely verbal information.

The major implication of Greenfield's studies is that broadly-based cognitive development requires a multimedia approach. She admits that direct experiences provide sound learning environments for children but, unlike Cuffaro and Zajonc, Greenfield acknowledges the realities of our multimedia society and suggests that **teachers need to utilize each medium to its best educational advantage**.

Greenfield's multimedia approach to the education of children should be kept in mind by teachers contemplating the introduction of computer-based art activities. The questions to be asked by such art teachers are probably not exclusive in nature (i.e., "Should *Macpaint* software **replace** my current studio emphasis on watercolour painting?") but rather inclusive (i.e., "How could the addition of *Macpaint* software **complement** my current studio emphasis on watercolour painting?").

The effectiveness of CAL is difficult to determine even when **drill and practice**, **simulation**, or **tutorial** applications within left-brain fields, such as language and numeracy, are involved. It is even less possible to objectively determine the effectiveness of CAL when the computer is used as a creative **tool** or **medium** within right-brain subjects, such as art or Music. Perhaps the effectiveness of computer-based art activities can best be determined by individual practitioners through their subjective comparison of student achievements with computer software against those produced with traditional art media.

2.2.10 ANALYSIS OF EMERGENT CATEGORIES

2.2.10.1 The Constant Comparative Method of Qualitative Analysis

The Grounded Theory (Glaser and Strauss, 1967) approach used within this research project resulted in the compilation of **comparative** data. The data appeared in the form of saturated categories. The categories were developed as emergent entities from observations collected and interviews conducted by the RUCCUS Research Officers during four consecutive school semesters.

Comparative data obtained through theoretical sampling is neither extensive enough nor coded enough to allow for the *testing* of a theory or hypothesis; it can only *suggest* or *generate* theory.

The testing of hypotheses, as such, is left to quantitative methodologies predicated upon random sampling procedures.

Glaser and Strauss put forward a method of analyzing data, based upon theoretical sampling, called **the constant comparative method of qualitative analysis**. There are 4 steps to the method:

1. **Comparing incidents applicable to each category**
   Emergent categories are filled with *incidents* or *evidence* that is compared to both previous entries within the same category and with entries across categories. Theoretical properties of each category begin to surface as the constant comparison continues.
2. **Integrating categories and their properties**
   As the analyst continues to codify incoming data, the comparisons begin to shift away from incident to incident toward incidents and emergent properties of each category.
3. **Delimiting the theory**
   a. The theory begins to gel and the analyst discovers fewer discordant elements within the categories. Terminologies and generalizations are reduced as uniformities surge from the increasingly saturated categories.
   b. The number of distinct categories decreases as linkages break down the barriers and the underlying causes for the original categories. Saturation occurs when incoming incidents merely replicate and reinforce previously coded material.
4. **Writing the theory/Formulating recommendations**
   Memos/reports written during the coding process become the content of the final research report.

Steps 1 through 3 have already been undertaken; the resultant saturated categories were listed in Section 2.1.8. For each of the categories, **student backgrounds, teacher profiles, classroom environments, classroom dynamics,** and **curricular structures** the data entries were classified by frequency of observation:

a. **data entries with a HIGH FREQUENCY of observation were printed in bold type;**
b. data entries with a MODERATE FREQUENCY of observation were printed in normal type; and,
c. *data entries with a LOW FREQUENCY of observation were printed in italicized type.*

Prior to the formulation of specific recommendations, a brief analysis of each saturated category will be undertaken.

2.2.10.2 Student Backgrounds **(Data Group A)**

The data entries within this category often contradicted findings related to **student backgrounds** uncovered by the other Principal Investigators. For example, the art students rarely volunteered any gender-related issues with the Research Officers. When pressed, however, they *thought* that students oriented towards subjects such as Mathematics and Science would be more drawn to computer art activities. This non-issue could be accounted for simply by the relatively balanced sex ratio in the observed art classes, as opposed to the male environment within technological studies and the female composition of family studies.

It is the opinion of this Principal Investigator, however, that the absence of gender-related issues was more likely a reflection of the art sub culture operating within the classrooms observed. Sub cultural elements which could have reduced the emergence and frequency of gender-related issues included: the acceptance of diverse subject matter within art assignments; the encouragement of peer teaching; and, an emphasis upon peer interactions during studio classes.

Other recurring data related to student backgrounds centred upon the minimal carry-over values previous elementary grade exposures to CAL had for the art students. For example, previous keyboarding experience offered minimal advantages to art students because of the heavy reliance upon user-friendly **icons** within most computer art software. As well, previous exposure to rudimentary computers, such as Commodore 64s, were of minimal value to graphic art students operating more sophisticated ICON and Mac computers.

2.2.10.3 **Teacher Profiles (Data Group B)**

Although the two cooperating practitioners taught different courses, visual arts (academic) and graphic arts (vocational), they employed remarkably similar pedagogic techniques. Both teachers relied upon indirect pedagogic approaches, employed democratic principles in the classroom, encouraged student ownership of studio projects, and fostered positive attitudes/self-confidence in their students. Their *coaching* pedagogies reinforced an art sub culture noticeably different from those observed in most of the other research classrooms. It should be noted, however, that the previous sentence contained the phrase "**an** art sub culture". Art classrooms can also be founded upon *master artist* pedagogies which produce art subcultures not unlike those observed by the Research Officers in the history and geography classes. It is important, therefore, to understand that subject subcultures are not uniform across Ontario schools; the key element of teacher background can produce widely divergent curricular structures within subject sub cultures.

The two cooperating practitioners shared common approaches to the introduction of art-based CAL in several key areas; while both teachers used their computers during the preparation of curricular materials, neither used their computers for administrative tasks. As well, both teachers retained their existing courses of study by applying computer applications to previously planned projects. Finally, and perhaps most importantly, both teachers considered the computer an artistic medium rather than a pedagogic device.

2.2.10.4 **Classroom Environments (Data Group C)**

The predominantly student-based curricula observed at both schools predictably produced visibly free classroom environments: rotation schedules were not rigidly enforced at Tecumseh; students moved frequently between studio and computer laboratory facilities at Brock; and, technical problems related to computer art projects were often solved through individual experimentation or group interactions, rather than teacher intervention. Displays of computer artwork were frequently observed at both school sites.

Both practitioners were adamant that laboratory **and** classroom computer facilities were needed to successfully nurture CAL. As well, they agreed that their reliance upon the site supervisor declined as their CAL experience increased.

2.2.10.5 Classroom Dynamics (Data Group D)

Paralleling the visibly free classroom environments at the research sites, the Research Officers observed numerous instances of highly interactive classroom dynamics. As previously noted, examples of peer teaching and observation occurred regularly during studio classes. Student ownership of projects was in evidence at each stage of the creative process. The teachers typically asked their students to solve design problems themselves through self-examination and the application of generic problem-solving techniques. As well, student self-evaluation processes were used extensively; final grades were often the result of student/teacher conferencing.

The establishment and maintenance of *coaching* pedagogic styles required unusually high thresholds of professional tolerance in the curricular spheres of: noise; space; size of group; decision-making; teacher interests; evaluation and standards; and, role.

The teachers frequently mentioned that they "learn a lot from the students" and derive much pleasure as educators from assisting their students in the realm of social development.

2.2.10.6 Curricular Structures (Data Group E)

The art students had opportunities to explore only a few software packages. *Spectricon, Draw*, and *IPaint* were the principal art packages used at both schools. Some students became acquainted with more generic software, such as *Co-Co, Curriculum Crosswords*, and *Show'n Tell. Art Treasures* was used at Brock, however, its non-chronological sequencing made it unsuitable at Tecumseh. The absence of visual images within the *Grolier Encyclopedia* software package rendered it of little value to art students across-the-board. Many of the Brock students found the text-producing capabilities of the ICON computers too limited; as a result, they relied on *Pagemaker* on their Mac computer for the generation of text for layout paste-ups. In summary, the software packages used within the art portion of this project were found to be too few in number, incapable of meeting the vocational needs of graphic arts, and unable to sustain student motivation beyond the attainment of rudimentary computer skills. While appealing to the students, the colour printers used during the project proved problematic on several levels, such as excessive print costs, poor colour reliability, and restrictive print sizes.

The cooperating teachers usually left the choice of subject matter up to their students. This resulted in predictable thematic content with stereotypical elements related to age and gender. As well, many male students appeared to be preoccupied with producing precise images. Virtually all art students reacted positively to the computer assignments at both research schools.

2.2.11 **RECOMMENDATIONS**

1. Ministry of Education policies, directives, and guidelines related to CAL must be flexible enough to accommodate diverse subject subcultures and teacher backgrounds.
2. The systemic adoption of CAL throughout Ontario schools would be best achieved through the introduction of subject-specific computer curricula.
3. Ministry of Education curriculum writing teams should include computer specialists drawn from the subject discipline involved.
4. Future Ministry guidelines for art (academic and vocational) should place greater emphasis upon computer applications within the discipline.

5. Future schools should be designed to provide both centrally located computer laboratories and in-class computer facilities.
6. The Ministry of Education should continue to acknowledge (as it has in its recent announcement of funding for GEMS 1B systems) that specialized curricular areas, such as graphic arts, often require computer facilities beyond those provided by the GEMS 1A systems.
7. An array of Additional Qualification Courses for CAL should be available, each responding to a specific subject subculture.

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2.3 TECHNOLOGICAL AND FAMILY STUDIES
by Valerie Rhea

2.3.1 INTRODUCTION

The data included in this summative report were gathered by the research team during the entire project period, spanning the 1988-1991 school years. This included one term of organization and planning, four terms of observations, and one term of feedback, data analysis and report writing. A family studies teacher and a technological studies teacher from each of the two selected secondary schools, together with their various classes, participated in the research throughout the life of the project. These family studies teachers, Betty Brinson and Diane Mirabella, were involved in teaching a variety of courses, including: sewing, foods, parenting, nutrition and diet therapy and personal life management. The participant technological studies, Carl Higgins and Ken Morton, teachers taught drafting, electricity, electronics and computer technology courses.

2.3.2 RESEARCH METHODOLOGY

The research methodology undertaken for this portion of the project is consistent with that of the overall research project. This has been discussed in detail in *Interim Report #1* (Goodson, Mangan & Rhea, 1989) as well as Volume 1 of this Summative Report. Mainly qualitative in nature, it was supplemented by quantitative research methods. Briefly, this project is based on the principles of grounded theory (Glaser and Strauss, 1967; Strauss and Corbin, 1990), allowing the theory to emerge from the data, rather than beginning the research with clear hypotheses and goals.

Parlett and Hamilton's (1977) illuminative evaluation further develops this focus on qualitative research, indicating the inadequacies of traditional quantitative research for educational innovation. These reasons, which were cited in *Interim Report #1*, include: the ethical implications of manipulating educational settings and the people involved; the impossibility of controlling ongoing changes during the implementation of the innovative program; the risks of losing important relevant data not included in pre-defined objectives; and the insensitivity of large-scale projects to local perturbations and unusual effects. Such effects, which may be crucial to an understanding of the overall situation, are better appreciated through small-sample intensive research (Goodson, Mangan and Rhea, 1989, p. 28).

2.3.2.1 Data Sources

The data, gathered over three years, have focused on forms of qualitative research, including: observing regular classroom and computer-use sessions, videotaping, conducting feedback sessions with teachers, and interviewing teachers and students regarding their computer experiences. These interviews were transcribed and observations written prior to being loaded into a textual database which approached a total of 9000 records upon completion of the project. These were supplemented by the more traditional quantitative forms of research, including the administration and analysis of a student questionnaire (see Volume 1) and the tracking of classroom interactions and cognitive patterns, both with and without computer use (see Volume 3). The findings from analysis of these data will be presented in the subsequent sections.

2.3.3 UNCAL TYPOLOGY OF LEARNING ACTIVITIES

As stated in *Interim Report #1* (Goodson, Mangan & Rhea, 1989), the project team as a group agreed to undertake the research with the *Understanding Computer-Assisted Learning* (UNCAL) typology of learning activities (MacDonald et al., 1977). This was chosen over those of Bloom et al. (1956/1972) and Gagné and Briggs (1974/1988) specifically because of its relevance to computer-assisted learning, which was found to be lacking in the others. To briefly review the categorization put forth by the UNCAL typology (MacDonald et al., 1977), the twofold system of "Student-CAL (computer-assisted learning) Interaction" and "Computer Activities" must be addressed.

2.3.3.1 UNCAL Student-CAL Interaction

The **Student-CAL Interaction** model included the following levels of learner and computer-assisted learning activities:

- i. **Recognition** tasks, involving yes-or-no types of learner responses
- ii. **Recall** tasks, typically requiring fill-in-the-blank kinds of responses
- iii. **Reconstructive Understanding** tasks, generally multiple-choice questions
- iv. **Global Reconstructive** tasks, generally open-ended, learner-directed interactions
- v. **Constructive Understanding** tasks, more open-ended than the previous category, requiring original knowledge

2.3.3.2 UNCAL Computer Activities

The UNCAL typology also included four levels of cognitive activities, and is reported under categories of **Computer Activities**:

- i. **Instructional CAL**, involving drill, practice, and tutorial exercises
- ii. **Revelatory CAL**, with simulations and trial-and-error exercises
- iii. **Conjectural CAL**, relating to the creation of new knowledge
- iv. **Emancipatory CAL**, which free users from routine, time-consuming tasks

2.3.4 COMPUTER ACTIVITIES

As indicated in the technological studies report of *Interim Report #3* (Haché, 1990), the decisions regarding which approach teachers will use with computers in education are complex, as there is evidence of varying practices, strategies, styles and perceptions of what creates effective presentation of the technological and family studies content. Many of the activities reported in *Interim Reports #4 and #5* (Rhea, 1990, 1991) will be further discussed in this report, followed by recommendations specific to the family and technological studies areas. At this time, it is appropriate to look at the actual approaches taken by the participant teachers, each coping with their own subject area content, software available and physical setup of computer installation.

2.3.4.1 Family Studies

Having participating family studies teachers in both schools, we were able to observe very different approaches and techniques for using computers in this subject area. While both teachers used much of the same software, they did so in different ways, resulting in different successes and problems. Among other things, both classes used *Spectricon* or *Draw* to create title pages, *Food Nutrient Tally* to analyze their diets, and *WPro* or *Write* to type assignments.

2.3.4.1.1 *Findings from Tecumseh*

At Tecumseh, where there are small clusters of computers in each of the classrooms involved in the research project, Betty Brinson generally taught the students how to use software in small groups and relied on the students to assist each other after reaching an initial level of comfort. As she says,:

> I just taught them in groups of about three, individually. They rotated though. The day, half the class was cooking and the rest of them had other assignments and I just took three or four of them, sometimes they worked in pairs, so there might be six of them at a computer. Some days I put three of them in Elliot's room as well because his room is empty that period.

This was not without complications, however, as she says,

> ... the frustration for me is the kids in here need me and the kids on the computers want my attention too.

and

> It's so slow trying to get the whole class through one exercise when only three can do it at a time.

As noted elsewhere, this teacher also would prefer a combination of a computer lab as well as classroom computers:

> I think it would be nice to have both access to a lab--then if you wanted to take a whole class and spend the whole period to maybe introduce them to something, then having three in the room would be ideal for them to finish up or to do another similar project on their own.

Betty used *Food Nutrient Tally* with her students to track their daily food intake, but was frustrated at that time with being unable to print out the resultant tally. Later, after speaking with Diane, her counterpart at the other high school involved in the project, she found that it was possible to print as she wanted. While this would improve the capabilities of the program, she also thought that there were commercially available programs that were superior to this one for the topic of nutrition.

Interesting group dynamics were also apparent with this group. Although Betty was relatively unfamiliar with *Spectricon*, several of the students had encountered it in other classes and taught the remainder of their classmates to use it to produce title pages for projects. The students then visited the Art room, where the colour printer is located, to obtain a colour print-out of their work. This exemplifies not only a great deal of peer tutoring, but also interaction between teachers of subject areas that would normally not exist. These interactions are seen in a positive light by Betty in the following:

> And this is what the Ministry says we're supposed to be doing is collaborative learning. And I think the use of the computer really enhances that, because they are really good at helping each other.

With another class of family studies students, *Democalc* was used for graphing. Again, Betty instructed some students originally, but was assisted by a great deal of peer tutoring. She did not force students to use this program, but rather gave them the opportunity to do the graphs by hand or computer. She reported that three groups of students chose to do it by hand, and the others used the computer. This aided in her classroom management, as there were only three computers in her classroom. Again, she supplemented this with using computers in other classrooms. In this particular case, she was not even teaching in her own room [where the computers were located], so all students using the computers were out of the classroom. She comments on this creating a:

> ...bit of a management problem though with some of those students. Like to just take off. They'd go in and work and then they would just decide when they wanted to go to the washroom, they'd just leave without permission. We had an incident one day when students were working in there....and boxes of brand-new yearbooks were sitting in there and six were stolen. So, you can see the problems of having students working in two rooms, even though you like to think you can trust them. It's a problem. And then when you have three more across the hall, you know, again, there's a tendency that they will just--with some of those students I had in that class—had a tendency to just take off when they wanted to.

2.3.4.1.2 *Findings from Brock*

This peer interaction was also noticeable at Brock, where the computers are arranged in a laboratory setting. In this case, however, the results were more positive for the intended curriculum, as can be seen in this fieldnote written while observing Diane Mirabella's class using *Food Nutrient Tally*:

> Diane is still circling the lab, assisting students as necessary. They are also helping each other a great deal. Although each student has their own computer, there is a lot of discussion between students. They are not only helping each other with technical questions, but informing each other on which page they can find certain information and in making decisions about their diets. Those who need help not available from other students raise their hand and wait for their teacher to come to them...Aside from a few trivial questions, the students are working very independently of their teacher.

This productive classroom atmosphere was no accident. Diane had handed out concise instruction sheets to the students, each with a clear motto of "**Concentrate, Have fun, Help each other**". These sheets outlined login procedures, activities and expectations for each student at the end of the assignments. This seemed to reduce confusion for all students, but especially so for those who arrived in class late or were absent for a day, thereby missing verbal introductions to the programs.

This computer laboratory setup had complications as well. As noted in *Interim Report #2* (Haché, 1989), the need to book the computer laboratory well in advance created problems. While offering the benefit of allowing the entire class to access the computers at the same time, the flexibility of the teaching schedule was diminished when the lab was in great demand. This meant that at times students began assignments without the full requisite classroom knowledge, supplemented by further instruction in the lab; at other times the teacher would attempt to re-book the computer lab at a later date so curriculum topics could be completed first, requiring further rearrangement of classroom routines.

This problem can be clearly seen in the following extracts from an observer's fieldnotes:

> Diane had her foods class in the computer lab for a final day to finish their assignment. The peculiar thing about this was that she was visibly ill. She said that she felt completely awful, and that if it was not a day that she had the lab booked, she would have called in a supply teacher. She did not feel confident leaving the students in the lab with a supply teacher who didn't know how to use the system. I asked if she thought that her students,

since they were at the end of the assignment, might be confident and competent enough to complete the assignment on their own, even with a non-computer-literate teacher. She said that she would not want to try that, for at the stage they were at in their assignment, it was especially crucial that things went smoothly. If the system went down or students made errors and lost their work, this was the point at which they would have the most to lose, so it was imperative that she be there.

The booking of the lab was also an issue here. The lab is becoming very booked at this time, and [the teacher] felt that if she forfeited this morning's computer session, she would not be able to get her class in for quite a while as the [lab sign-up] sheets are almost full.

Regardless of the reasons, it is mentionable that this teacher's activities are being organized around computer use, not only in terms of **what** she teaches, but when she can/cannot be sick! This is a major change from a couple of years ago, when she had never used a computer in her classes.

2.3.4.1.3 *Comparison of Approaches*

Thus, the teachers in each of the two schools have adapted differently to the physical setup they experience. Betty, the teacher at Tecumseh finds it best to use computers for frequent small bits of time, enabling all students a chance to rotate through a computer use schedule, while Diane, the Brock teacher, chose to use the computers in larger blocks of time, thereby reducing the need for estimation of appropriate dates for computer use periods.

Both teachers involved have used *Food Nutrient Tally* with their classes, and have noted different benefits and problems with the program. Betty reported that the text screens at the end of the program were the same for all students, regardless of the results of their diet. It was also noted that the program lacks a quick exit causing the students to impatiently skip through the information and diet analysis screens as they exit the program. Diane mentioned that serving size in the program was not realistic and needed to be revised. She mentioned that she would also like the capability of adding foods to the program.

In spite of these shortcomings, both teachers felt that their students benefitted from the use of *Food Nutrient Tally*, in terms of their learning, motivation, time use, accuracy, and enjoyment:

Diane: It takes them about two or three days to analyze their diet if they do it by hand and it's very tedious and they hate doing it. Whereas the computers, you know it wasn't any faster because they had to learn how to get into the computer and how to use it and that sort of thing. But I think that it was more enjoyable for them...I think that perhaps their output was more accurate too because mistakes in addition of numbers and our math is, in our case math is not a real strength. I think that was better.

Interviewer: Just as a switch and variety in life?

Diane: Yeah. And I think that perhaps their output was, was more accurate too because mistakes in addition of numbers and our math is, in our case math is not a real strength. I think that was better.

And on another occasion, Diane said:

> I think they're learning perhaps more effectively in my case. They would do a much better job on the computer than I think they would do handling mathematical things by themselves. I know that a lot of them are working at grade 4 level in math for example and there's no way they could have analyzed their diets without using the computer and yet they were able to do that and to actually see the results and to get accurate results because they were using the computer. So it did allow them to do things that I don't think they could have done as well, on the computer, you know if they did it by hand. But just being out of the classroom I think and into somewhere else was really a good experience. Being on the computers and their interaction was a really excellent experience for them. I don't know, they just seemed to really enjoy it, they really seemed to enjoy it overall so. I mean we had the odd person who was frustrated but you're going to run into that anywhere.

Both teachers noted that they saw the possibilities of using a spreadsheet, such as *Democalc*, in their programs, and planned to do so in future terms, although they had not quite accomplished this yet. In Diane's words:

> I did try, mind you. I tried to set up a lesson...I never got it complete before the kids needed to use it. So that was the end of that. But another time, I'm definitely going to take a look...I would love to put our budget and stuff on a spreadsheet, for here.

And, on another occasion:

Diane: I think I would do a bit of graphing with them. We did do graphing but we did it by hand. Like we graphed our results from our survey. We took a classroom survey when we got back up what nutrients each student, and we graphed the results of that and, that sort of thing. I didn't do with them down there, I took us one period up here and it would have taken me ages downstairs, I thought, "No, that's enough", you know.

Interviewer: You could have done that on *Democalc* you're saying?

Diane: Oh yeah. And I think that spreadsheet would've been one more thing that I think would've used more. Perhaps even with the nursing students and when we do diets, we do diet therapy and I think that would be, you know changing just so they could see that when you do change for example a food in a diet that it does make a difference in sodium content of the diet, or it does make so that it would automatically adjust. I can see that, I can see using for that sort of thing.

And so, the teachers of family studies are progressing in their use of computers in their curriculum. Different courses and students require different approaches, and the teachers have been familiarizing themselves with this over the four terms of observations. They also show evidence that this development will continue in the future.

2.3.4.2 <u>Technological Studies</u>

2.3.4.2.1 *Findings from Tecumseh*

Technological studies has been plagued with problems relating to the physical setup of computers in the case of drafting and electronics at Tecumseh. During the first two terms of observation, while drafting software was available, it was unable to operate on ICON 2s, the main hardware selected for this project. After some time and effort, ICON 1s, which were able to run *CADTutor*, a drafting package, were located and put into the drafting rooms. This configuration was in place for the third term; however, Carl Higgins, the participant teacher was assigned to teach electronics instead of drafting. While appropriate electronics software was available to run on the computers, the computers were located in the drafting room. Thus, the situation changed from having incompatibility between software and hardware to incompatibility between location of the computers and that of students. This was compounded by the fact that another teacher was assigned to the room containing the computers and understandably did not welcome interruptions by students from other classes wishing to use the computers. While Carl had full plans for using the computers in his class he acknowledged the complex incompatibility problems:

> I haven't been able to involve the classes in the use of the computer because I've been teaching in an area where the computer wasn't located. Yes, it worked totally against me. It's unfortunate, like that our administration hadn't co-ordinated the classes with that in mind. But I suppose maybe that's a little bit much to ask of them. They've got, I mean, they have to work against a lot of other things.

He hoped for an improvement during the fourth term, as he and the computers were relocated to a new drafting classroom with the computers situated in an attached side room, in what he considered an ideal setup. However, as we monitored the progress in this area over the last term, we found the setup to be far from ideal. *CADTutor*, the program for which much of this rearranging was done, was found by Carl and his students to be lacking in content and ease-of-use. Ironically, many of them found this tutorial program more difficult to use than the actual *AutoCAD*. However, all was not lost, as this coincided with the delivery of a single new stand-alone machine that was able to run the industry standard software, *AutoCAD*. So while the department did move ahead in its computer use, this was due to mainly to the acquisition of hardware external to the research project. In addition, the "ideal" side room that offered a separate work area and protection for the equipment, was found to be too small for the students to work in, and very cold in the winter months.

As a result of the software problems, the ICONs at Tecumseh are presently used mainly for word processing and drawing in the drafting area, and *Electronics Workbench* in the electronics area. Students are frequently encouraged to enter their notes and assignments on the computer. In addition to this, the students used *Spectricon* to do assignments in the design process. The teacher explained that people often put a great deal of effort into their hand-made drawings and that they are put in a specific mind-set because of all of this invested effort, and are loathe to make changes at that time. By using the computers, it is easy for the students to change the rough designs in order to generate alternatives very quickly in order to come up with the best possible designs on the computer. While technical problems would not allow them to print these designs from the drafting room, the students would sketch their options from the computer screens and work from there.

Carl plans to continue using the computers in the future with his drafting and electronics students. Anticipated applications are word processing, *Microsoft Works, Construction Cost Estimates, Democalc, Electronics Workbench* and *Electricity and Electronics*. This is in addition to the use of *AutoCAD* on the stand-alone system in the classroom, and the experimental use of new state-of-the-art computer-assisted-learning packages in electronics, that include a circuit assembly hands-on component. The department was also given a large sum of money to rejuvenate the entire technical area, as Carl said:

> We're really getting into things like computer assisted learning, and digital electronics and their applications for electronics. Technical Education's becoming much more cerebral and less, and less tactile, less practical. Less practical in the old sense. It's not trades-oriented. It's more cybernetics... the whole problem of economic survival depends on thinking faster, smarter, or obviously the computer is going to aid in that process. The other aspect is that because we're going to have in the drafting room about ten computers and within a year and in the Manufacturing Processes we'll also have computers and in the woodshop and in the autoshop we've got there'll be about ten pieces of software controlled by a computer. I mean it's very much a fact of life. It's revolutionary, the change that will occur in the next year. This whole introduction to the ICON came in the nick of time actually because I think it has given my teachers a mindset which is necessary.

2.3.4.2.2 *Findings from Brock*

In comparison to Tecumseh, Ken Morton, the Brock electronics teacher presently has had uncomplicated access to the computers. Not only does he have a variety of stand-alone computers in his classroom, but his room is located adjacent to the ICON computer lab. Other computers available in his classroom to his students include Ataris, Commodores, IBMs and IBM-compatible machines, which run *AutoCAD, AutoSketch* and *SmartWorks*, a program which allows them to design printer circuit boards. The students are able to design a board, take a copy to the school's Graphic Arts department, and make a negative which enables them to make a parent circuit board.

In addition to the work done on the classroom computers, students at Brock have used the ICON computer lab to work on *Electronics Workbench, Electricity and Electronics, Logic Gates* and *Write*. In earlier terms, Ken was particularly pleased with the use of *Logic Gates* with his grade 10 students:

> Grade 10 is actually a unit study—they go at their own rate. We just took a block of time, took two days out of nowhere and gave it to them and then as a rule they got to that section and progressed much faster...

During the fourth term of observations, the ICONs were successfully used with all of the grade 9 students, who rotated through the electronics portion of the technology program on a 15-day cycle, for a one-day session with *Draw* and *Write*, involving the investigation of careers in electronics. Ken found this to be a positive experience for the students, resulting in favourable reactions to computing.

Electronics Workbench was used both on the PW-300 stand-alone machine and on the ICON network this term with senior electronics students. In spite of the slowness of the ICON network while using this program, some positive results were obtained this time. As Ken reported:

> The most recent one I've done is using *Electronics Workbench* and it's the first thing that's worked and it's worked well. Just doing straight reactants, problems where they've plotted, they could change frequencies, they did two labs in a period. Those that could go through it and understood what was happening and that's a lab that could take a week

in a regular classroom. And they probably get more out of it because they see it all at once and they see what's happening. So that's been a good exercise.

Ken also chose to use the computers in his senior classes more with his advanced level students than the general level ones. He said that he did so because he had a combined class of both advanced and general level students, and using the computers offered the advanced level students a "little bit of a different challenge while some of the other students are completing the [classroom] labs". In this way, the computer programs were sometimes used as an enrichment, or more in-depth activity for advanced level students.

With his extensive background with computers, Ken has strong feelings about computer use and the benefits of various hardware setups. He also highlights the importance of running what has become industry-standard software in his vocational subject area. In many cases, this software is not available on the ICON system. He has mixed feelings about the present setup however, and he goes on to say:

> There are some real advantages to the lab situation for a limited period of time. Like, I've found that four or five days in each course is, it's been great. It's really done its job where you can talk to the whole group about one particular thing but after we get past that then I'm on into use of the computer in the classroom. So there is a function for both. And it doesn't really matter whether it's the ICON or the IBM. It would be nice if it was the IBM as far as I'm concerned but the concepts of teaching are, it could be any system.

Following individual instruction with the use of *Democalc* with John Rutledge, the Principal Investigator studying the use of spreadsheets across the curriculum, the teacher was able to incorporate the use of *Democalc* into the electronics program this term. As he said:

Ken: Okay, *Democalc* was used on two different occasions, and that works well, but I've used this pretty well with the advanced level students in the class. I did one with series circuits and one with parallel circuit where they've, I've started the problem, I've done the first two columns and they've completed the series one and then gone on to the parallel. It's a nice system because you can go back in and check exactly what they've done, by looking at the formulas they've used in the blocks and that's, that was really, that's a good exercise.

Interviewer: Now how would you have done that in the regular classroom, how would you've handled that, would you just do...?

Ken: A series of assignments.

Interviewer: And that way...?

Ken: They do a practical type thing in the class but I want them to do that because they're getting familiar with meters and how to use meters and what have you. But the actual problems, in fact it when they're all through and they can change the value of one resistor and all the answers come up immediately, they realize just what a computer can do because they've gone through the exercise and taken a half an hour or three quarters to solve some of the individual problems.

Interviewer: So that way it saves time for them?

Ken: Yeah and they probably see faster, they probably see the relationships faster. That's been a good exercise.

This *Democalc* use is planned for future terms as well by the electronics teacher, as he sees numerous uses for it in the AC theory portion of the grade 12 course. He thinks that *Democalc* will be particularly useful in this course as they presently have trouble giving labs in AC theory that are meaningful without being time consuming.

The word processing package, *WPro*, was also used with the electronics students this term. With this program, the students were given the opportunity to print out all of the definitions they desired on a piece of paper, which they could then take with them into tests and exams. At the time, the students were very keen on doing so, but surprisingly, Ken reported that many of the students forgot about the sheet by exam time.

2.3.4.2.3 *Comparison of Approaches*

As can be seen, similar to the family studies teachers, both the teachers of drafting and electronics are continuing to plan alternate activities involving the use of computers in their subject areas, and their use of the programs is developing as their expertise increases. Differing availability of equipment and physical setup of the computers has been the major variable in the levels of takeup by the two teachers. The recent installation of additional computer equipment meeting present industry standards into the technological studies department at Tecumseh has the potential to revolutionize the instruction of technological courses at the school.

2.3.5 ISSUES RELATED TO COMPUTER INTEGRATION

2.3.5.1 Levels of Learning Activities Observed

Having a grasp of the different applications made by the participant teachers in the use of the computers, it is now possible to analyze their observed computer activities according to the UNCAL typology (MacDonald et al., 1977) discussed in 2.3.3 of this report. As much of the software was not subject-specific but rather generic in nature, teachers of both technological and family studies often used the same programs. For this reason, this analysis will occur by software program rather than subject.

All of the teachers involved used word processors (*Write, WPro, Microsoft Works,* or *WordPerfect*) with their students. In all cases, this can been seen to be **emancipatory**, as it frees the students from time-consuming tasks. Students can edit their work quickly and easily, saving and printing a revised version of their work, leaving a greater time for analysis and thought. In this way, students are spared the wastage of time on inauthentic learning or "busy work".

Similarly, all of the teachers used a drawing program (*Spectricon* or *Draw*) with their students. While in some cases it was simply used to create title pages, other classes used the program to design floor plans, revising, saving and re-designing optional arrangements. In both cases, but more so in the latter, again the work can be seen as **emancipatory** for the students. Students have the option to try other ideas without having to start from the base line each time, but rather can build on what they have already designed. This work is also generally at the higher ends of the student-CAL interaction, involving **global reconstructive** and **constructive understanding** tasks. Such designs are generally original, open-ended and learner-directed activities.

Students using *Food Nutrient Tally* experienced a variety of levels of learning activities. While the simple input of diet contents into the program could be seen to be at the level of **recall**, the subsequent analysis of their diets was at a much higher level of **global reconstruction**. As a simulation of their real-life experiences, this activity was **revelatory**, while at the same time, **emancipatory** sparing them from looking up the values for each of their foods in numerous tables in books.

Spreadsheet users (*Democalc, Microsoft Works*) were also freed from time-consuming tasks, thereby experiencing **emancipatory CAL**. However, the use of spreadsheets offered much more than time-saving features. While some classes used only the graphing aspect of the program, others pursued much higher level thinking tasks. As some teachers commented, it allowed their students to actually do analyses they would not have had the opportunity to do as they lacked the mathematical skills to manipulate the numbers in preparation for these analyses. Activities that were beyond their grasp suddenly became realized. The spreadsheets allowed students to explore various "what if" scenarios. This learning was often of the **global reconstructive** and **constructive understanding** levels.

Logic Gates and *Electronics Workbench* were both used by the electronics classes. They offered a variety of levels of activities, depending upon what portion of the programs were used. The tutorials offered **instructional CAL**, while the simulations offered **revelatory CAL**. The time-saving features over actually setting up the circuits in the classroom offered **emancipatory CAL** for the students. Again, dependent on which portion of the programs being used, and whether a student was completing a tutorial or creating and testing new circuits, all five levels of student-CAL interaction could be experienced.

Lastly, in the courses using CAD programs, a variety of lessons could also be experienced by the students. While *CADTutor* offered the lower level computer activities of **instructional** and **revelatory CAL**, and **recognition** and **recall** tasks, the creations with *AutoCAD* were of higher levels on both scales. The creation of new designs in a time-saving fashion was both **conjectural** and **emancipatory** for students. The interaction also had the potential to be at the highest levels of **global reconstructive** and **constructive understanding**.

2.3.5.2 <u>Professional Development, Transitions</u>

During both teacher feedback sessions, all of the teachers commented that they felt that in-depth training for teachers was of greatest importance, both at the pre-service and in-service levels. Diane stated that it was most important that all teachers graduating from a faculty of education be computer literate and that this must be accomplished very soon, not in ten years as suggested. Recognizing that this would incur a great expense, she felt that this should be in addition to the training given to existing teachers, or else we will be just falling further behind all of the time. She recognized that this will require a massive training effort, and is not something that can be picked up in an hour after school. This **must** be done, however, as Betty says:

> There's no point pouring money into equipment in every classroom if you're not going to do a really good job of training the teachers. Or else it would be wasted in some cases.

And, as Diane said,

> I think that one of the recommendations that have <u>got</u> to come through is this bit about computer literacy, is about graduating teachers who are computer literate. And I think that, I think that's got to be right at the top of the list.

As far as the professional development for this project goes, the teachers seem quite satisfied. In addition to the training given at the beginning of the project, and the on-going subject-specific training, all teachers reported that they enjoyed attending the Educational Computing Organization of Ontario (ECOO) conference during April 1990 and May 1991. It offered them opportunities to observe what other teachers were doing and consider options for the future. As Betty stated stated:

> I was really impressed with the variety of sessions and topics, and the technical expertise of some of the people. I tended to go to the fairly general ones, 'cause I thought a lot of them would be over my head, but I got a lot out of those. The philosophy, and some of what was going on.

Outside of the project, the technological and family studies teachers have also been further-advancing their computer expertise. For instance, Diane attended a 7-hour WordPerfect session on her own time, and Carl has participated in AutoCAD training on five Saturdays during the past term. Much of this interest to do so has been indirectly attributed to experience with this project, as Betty said:

> I'm really pleased I am involved because I've learned so much. I mean I probably, if I hadn't been involved I would still not be using a computer at all. So it's, you know, I can see the potential for, just for teacher use so much. And I've done much more this year than I did last year. I'll get better and better and do more next year.
>
> I have some goals that I've had for a while. One of them was word processing. I really wanted to get to the point where I was really literate. So when I sat down I did my stuff right into a computer rather than writing it out first. And I have now got to that point. So that, certainly that is one thing that I personally benefitted.

While the frequency of the need for technical support dropped off during the course of the project, teachers felt very strongly how much it was required. At the beginning of the project, when they needed training and the bugs were still being ironed out of the networks, the need for support was very great. As the project progressed, and the confidence level of the teachers increased, this demand for support decreased, but was still considered necessary.

2.3.5.3 <u>Importance of Computer Literacy</u>

Again, all the teachers agreed that computer literacy was of the utmost importance, and something that all teachers and students must work toward. Following through with this, they all instructed their students in the use of a word-processing package as well as a spreadsheet, although to varying degrees. Their commitment can be heard in the following extracts from interviews with three technological and family studies teachers at different times:

Diane: Oh I think everything is going to be more and more computerized. To the point that you're going to have to be, it's going to be like reading ... if you can't do it, your life is going to be totally miserable, if you don't know how to work a computer. Like that's not far down the road...

Betty: If I don't teach it, they're not going to learn it somewhere else. So I don't see it eclipsing my subject at the moment, but if they're not getting it anywhere else, maybe I'd feel that I should cut out part of the curriculum to make more room for that....I think it's probably better if they can have it integrated into other subjects, so they get more practice and they're doing it all the time. Take one course and never see the computer again, they don't touch it. I think it's a skill you have to keep using, or you forget it.

Carl: I believe that everybody should be technically literate...I think a basic familiarity with, what I regard as being the *lingua franca* of the computer world. I would say something like *Lotus* and *WordPerfect*, are the two programs that I can think of that would have almost universal application and I think that everybody should be exposed to them.

Interviewer: How much of your time would you be willing to give up in order to do that?

Carl: 25% probably.

Interviewer: What you are teaching could really drastically change. 25% is quite a bit.

Carl: 25% of [what I teach] is doing math...

Interviewer: Would you be replacing that or in addition to...?

Carl: Within [my subject area] students write essays...resumé writing and letters of application...and so writing is a part of the course. Remedial math...is a part of the course. And so to include something that increases a person's familiarity with...spreadsheets or to be able to produce a document that looks polished, I don't regard it as an intrusion, just simply part of the course.

Diane: It's definitely worth the money. There's no question about that...When they get out into the real world, what are they going to run into? They're going to have to be computer literate...Eventually what's going to have to happen is they're going to have to take their heads out of the sand and say, "Teachers must be computer literate, students must be computer literate."

Thus, computer literacy seems to be increasingly important in the technological and family studies areas. In addition to the "basics" that teachers of other subject areas feel students should have, technological and family studies teachers are also concerned with their students' familiarizing themselves with the software that they will be required to use in the workplace upon completion of their education. Many of these teachers commented that the present hardware and software configuration did not allow them adequate access to the growing educational and industrial standards for integrating skill and theory software for technological education.

2.3.5.4 Administrative Uses

All teachers in the technological and family studies areas have used the computers for a growing list of administrative uses: typing minutes, letters, typing exams, classroom assignments, and recording marks. They continue to be impressed with the speed with which they are able to complete regular classroom tasks. This was perceived as providing a greater freedom in completing tedious chores. The teachers also noted that not only was the dependence on the part of teachers increasing, but the same was true for students. Students from previous terms dropped by occasionally to use computers in their classrooms to type up assignments or resumés.

IMark is being used quite successfully on the ICON to manage classroom marks by most of the teachers at this time. Diane purchased another program for her convenient use at home, but when she found out that it did not work as she thought it would, switched back to the now-familiar *Imark*. *Class Manager*, and another marks management program by Maplewood Computing are also being used by a couple of the teachers on MS-DOS machines.

Diane noted that despite her training in *WordPerfect*, her great familiarity with a more basic program that was initially introduced to teachers, *Write*, prompted her to use it more. Her greater comfort level with this program was a major concern to her:

> I know *WordPerfect*, but when I'm in a hurry I use *Write*, because I know it a lot better and it's really fast, right? And until, until you get really good at it, it saves a lot of time not having to look up in the manual or whatever, it really does. I mean you can sit there and do *Write*—like an exam in an hour, you can type it in and get your printout and that's the end of it. So I still use it, I mean and I still play with that, and I'm getting very good at paging now [laughs] and I mean there's lots of things that you learn to do because you have to.

Experience with the project and increasing familiarity and knowledge of computers prompted Diane to also convince her department to do some fundraising in order to purchase a computer for administrative uses during this past term. As she says in her following quote:

> I think every teacher should have computer experience...you've got to take that step somehow...And last year when they asked us for department objectives...that was one of the things that I put in was that this department needs to be computer literate now. And there it is. We did it. That's amazing...If I hadn't been involved in this study, I don't think that I would have pushed quite so hard because when you really get to the point where you're using it a lot and you're really enjoying it, I think you realize how easy it could make life for a lot of other people too...

2.3.5.5 <u>Gender Issues</u>

Traditionally, in terms of gender representation, technological and family studies classrooms have been very unbalanced. Although this trend seems to be changing, there is still a long way to go. At this time, there seems to be greater acceptance and incidence of males in family studies classrooms and females in drafting classes than there is of females in electronics classes. At this time it is still difficult to generalize gender differences with computer use within these areas, as there is still a gender imbalance in enrolment which is another issue completely. In spite of the gender imbalance in the classes, there were some gender differences noted in terms of computer use in technological and family studies, and this has been discussed in interviews with both teachers and students. While some of the teachers noted no differences in computer use of their students, others did see differences:

Interviewer: There are very few females there to start with.

Carl: In the drafting room there is...it can be as high as 50%. But in most technical areas it's less than a third and in some we don't get any girls at all. In electronics we didn't get any.

Interviewer: In electronics, there weren't any.

Carl: I don't know why electronics doesn't attract girls. It should. It is...the things most women have, patience, neatness, and concentration. But I think they probably think that it's a boy's field, you know, so they stay away from it.

Interviewer: Some of those stereotypes are hard to break.

Carl: Yeah, which is really sad.

One teacher noted that while both male and female students succeeded in the course work equally, the male students frequently chose to use the computers, the females did not, unless it was a word processing as.ignment.

Carl: But I have yet to see a girl go in and try the say the geography games, learning programs or whatever you call them. Just spontaneously go in and start exploring through the various things, they just didn't do it, they didn't, but many of the guys did.

Interviewer: So the only time that the females would go in there was when they had something they were specifically instructed to do?

Carl: Yeah, and generally then it was wordprocessing. Some of them would go in and they'd watch some of the guys doing a design.

Female students in one of the family studies classes were not impressed with the participation of the males when it came to computer use, finding them immature, and slowing the whole class down with their clowning around. These students felt that the lack of interest on the part of the males was due to the fact that males were not interested in diets and therefore *Food Nutrient Tally* was not something that motivated them. In addition, they thought that the males had to consider their reputation in this subject area, and as one female said,

> I don't think guys would want to work on computers as much as a girl would want to...Some people I talk to, they hate computers, they think it makes them feel like a sissy or something.

2.3.5.6 <u>Hardware Selection</u>

Almost all teachers in the technological and family studies area indicated a desire to use hardware that was able to run industry-standard software, whatever that happened to be in their subject area. Apple or MS-DOS software was frequently mentioned in the family studies area, while MS-DOS machines were requested in the drafting and electronics areas. The following excerpt from an interview with Betty illustrates this point:

Betty: Probably there are better programs, similar type of programs which we don't have on, a nutrient content. I think probably Apple has something more sophisticated.

Interviewer: ...in looking a little further down the road, do you think that they'll work in more to the curriculum and will you as the department head try to encourage that?

Betty: Oh I'll definitely try to encourage it. I mean I think they'll use them for word processing a lot.

Interviewer: Uh-huh.

Betty: I just wish we had more programs pertaining to family studies...

Interviewer: Yeah.

Betty: ...on that system. You know, it's pretty limited.

The teachers lamented the fact that there was very little applicable technological and family studies software available for the ICON. All teachers used the various word processing (*Write, WPro, WordPerfect*) and drawing (*Draw, Spectricon*) programs in their courses. As mentioned previously, the family studies area found *Food Nutrient Tally* the only appropriate subject-specific program. The electronics area had use of *Electronics Workbench*, which had mixed reviews, *Democalc*, and *Electricity and Electronics*. The drafting area attempted to use *CADTutor* but did so with great hardware complications (it would only run on ICON-1s) and little curricular gains.

2.3.5.7 Teacher Reactions

The teachers involved in the project continue to remain positive about the use of computers in technological and family studies. While problems with compatibility and slowness of one particular system or piece of software may frustrate a teacher, they all see the potential use of computers in their respective subject areas, in terms of students' learning, motivation, interest, and self-esteem, and for teacher use. The following extract from an interview with Diane says this well:

> I think anything that makes the student feel positive about themselves is going to help. And I think that a lot of students who are very shy to contribute to, to do group work or to do any of that sort of thing, will participate when it comes to doing computer group work, for example. Or, where I have a really strong student who never would go into another group and help someone who was very weak -- they will do that on the computer. So that they're not—they're increasing their self-esteem. It doesn't matter if it's the person that's helping out or the student that's very weak. And I think anything that makes a kid feel better about themselves is going to make them perform better in your class, or in their work or whatever. So definitely I see it fitting in just, very well.

Participation in the project has also increased the interaction among teachers who normally would not have reason to communicate within the large high schools. A common interest in computing and common needs in technical support and assistance has drawn many of the teachers together. While this need for support has decreased during the course of the project, this seems to have been seen as a positive thing by the participant teachers, including Diane:

> So this really sort of broadened ... I met a lot of new people who I normally wouldn't have met, and got to know. And I've really enjoyed that. I've really enjoyed the contacts very, very much. And you get to know them on a different level, then just saying "Hello" in the hall. You know, like, "My God, can you help me? This has crashed and I don't know what I've done wrong." So, I mean, you're definitely seeing them at a different, a different level. And I like that very much...I know that should I run into difficulty I can run across the hall and [another teacher] will be there to help. I don't think that feeling of camaraderie has gone. I just don't think that the time being spent is quite as intense as it was. I mean, there, I think that's the difference.

2.3.5.8 Student Reactions

Students also generally enjoyed the use of computers in their courses, whether seen as a challenge, preparation for future career opportunities or simply variety from the regular routine of classroom life. As interviews with students from each participating class were completed every term, the following student quotes were available from interview transcript extracts were available on this topic:

I think it's great for learning. That's what I think. It's what the world's made of practically with all the computers. You might as well learn when you're young. Everything's run on computers now.

I enjoy using computers to do my school work, because it makes things more interesting, and allows me to modify my work with ease.

While lower-level tasks on the computers are generally not given high priority by educators, one student, who did not have a strong background in his subject area, enjoyed the use of a computer program that allowed him to do repetitive tasks to strengthen his skills in his area:

I thought [the computer program] was good...because it's very repetitive...so that it sinks in...He taught it in class and then it didn't really sink in and then when I did it on the computer then it sunk in. A combination of the two would be really good, I think.

In addition, for the most part, students found the computer use time very informative, a necessary investment for the future:

Interviewer: So just overall what would you say your reaction is to using computers in schools right now?

Student #1: I think it's great for learning that's how I think. It's what the world's made of practically with all the computers. You might as well learn when you're young.

Interviewer: Do you think you'll need to know later?

Student #1: Well definitely. Everything's run on computers now.

The students also saw many benefits to using the computer for their personal use. For example, after a session with *Food Nutrient Tally*, one student stated that he was able to attribute his lack of energy to a lack of red meats, thereby applying it to his real life. Others in the class came in on their own time to analyze diets of other family members. Benefits were also seen by students when it came to written work and word processing. Editing was seen as very simple and time-saving when done on the computer, something that was done more often.

Students also noted that the use of computers increased peer interaction within the classroom. Rather than the teacher instructing all of the students in the use of computers (something logistically difficult to do anyway), many teachers counted on peers helping each other out with instruction and assistance using the computers. The students seemed to enjoy this opportunity, often reporting that they learned better in this fashion, as this student says:

Interviewer: So you just learned from a friend. Do you like that way of learning or would you...?

Student #2: Yeah it's easier than having an older person do it because I can talk with somebody my age.

Interviewer: So you find it easier to talk to a peer about it than to a teacher?

Student #2: Yeah cause if I don't understand I don't like to say explain it again and again but if it's a peer they understand how I don't understand.

A teacher found that it was also a good motivational tool for her students, as can be heard in this interview excerpt:

Diane: The, it was really interesting had one student who's a terrible, it's just awful, just very, very weak student and also very social-oriented which really shows up like a sore thumb in a class where you have very mature students. And he just shone because he had done computer work before. And since he was hopping from one of them to another one of them helping all of these high A students out with their difficulties. So that really was good for him.

Interviewer: For his self esteem.

Diane: Yeah, he certainly was pleased with himself.

Interviewer: Oh that's good. Did that transfer over back when he came into the class?

Diane: Yeah, I think he settled down a bit. And I think that they were perhaps a little more understanding of him maybe.

Diane also mentioned that she thought that although in comparison to other systems, the ICON system was quite simple to use, the younger students were more confident than the adult students, who often became frustrated initially when it came to computer use. She felt that they too, got over this, and came to see how useful the computers were, with some coming in on their spare time to analyze another family member's diet as well.

2.3.6 SUMMARY

While there have been a few technical problems, and desires for different hardware, I think it is safe to say that all of the teachers in the technological and family studies area have enjoyed their participation in the project. Perhaps this is best said in the words of one of the practitioners:

> It was, it was very fun, I would say. I loved the students' reaction, like I figure if it adds something to my students' knowledge in the time that they are in my subject area then I say yes it's really worthwhile whatever, whatever trouble or hassle or whatever it was. And it wasn't a whole lot. Like from the beginning there was always support, and you always knew that your problems would be taken care of and, and the students I think generally, from the feedback I got, there were very few students who didn't really enjoy having, you know having that experience of having been down there. It's a nice way of doing, it's a nice different teaching method. And I think that's good too because I think that there are so many different things you could do but then when you could move out of the classroom and get them into actually working with computers or it's the same as moving them to the library and having them do something or going out tramping around in the community doing something. I think it's really good they learn different things and I think that's really an important part of their education.

2.3.7 RECOMMENDATIONS FOR TECHNOLOGICAL AND FAMILY STUDIES

Following a review of the observations, interviews, questionnaires, and discussions with participant teachers at our second day-long feedback session to discuss such issues, the following recommendations can be made for the integration of computer technology into the areas of technological and family studies:

1. Appropriate hardware and software is imperative in the technological studies areas, as students often go directly from these programs into the work force or other training programs where such computer skills are prerequisite. There are several factors to consider in this regard:
   a) The use of industry-standard hardware, able to run corresponding software is essential, as use of these programs is to be a major component of the courses. These programs are generally unable to run on ICON equipment, requiring Stage IB IBM-compatible or Apple Macintosh machines. These standards vary from subject to subject, and selections should be made accordingly.
   b) Drafting courses presently require the use of *AutoCAD*, as well as the accompanying hardware and plotters.
   c) Electronics and computer technology courses require a variety of computer equipment and software programs. *Electronics Workbench* (IBM version), *AutoCAD, AutoSketch* and *SmartWorks* have successfully been used in these areas.
   d) As the aforementioned industry standards will change periodically, budgets for computer resources must be sufficient to keep systems reasonably up-to-date.
   e) This specific software use should be supplemented with tool software, including word processors, spreadsheets, databases, as well as tutorial software and graphics programs. This could be accomplished on many systems, and has successfully been done in this project on the ICON computers using such programs as *Democalc, Write, WPro, Electricity and Electronics, Logic Gates, Spectricon, Microsoft Works*, and *Watfile*.
2. The family studies area has a much different set of hardware and software needs:
   a) While family studies courses do not have the requirements for industry-standard software packages that technological studies courses do, they do require a greater variety of curriculum-based software than is presently available on the ICON. Present use on the ICON relies primarily on *Food Nutrient Tally*. A greater variety of Ministry-funded software or funds to purchase commercially-developed software are required.
   b) As there is very little curricular software available, computer use relies heavily on the use of tool software including *Write, WPro, Microsoft Works* and *Spectricon*. Such programs should continue to be made available to the family studies area.
3. As many of these industry-standard software packages are very complex and are often the basis for entire courses, teachers of these courses require extensive training time in order to effectively familiarize themselves with these and integrate computers into their curricula. Options for training, dependent on local needs and resources include:
   a) in-service training similar to what these teachers received, with one day a week release time and workshops for a month (minimum);

b) releasing interested teachers from teaching responsibilities for one period for one term in order to attend workshops, familiarize themselves with software, and design appropriate implementation strategies, and,

c) Board subsidy of teachers' tuition for Ministry-run Additional Qualifications courses held during the summer and night school, or other night courses held in the community specifically dealing with the software packages. Additional or revised Ministry courses may also be offered, dealing with some of these more specific issues.

d) following the initial training offered to teachers in one of the above manners, teachers should be given opportunities to remain up-to-date with the technology with regular professional development sessions.

4. As it is well-documented that technological and family studies courses are still generally unbalanced in gender, it is imperative that teachers in these areas take special care to support minority genders in the introduction of computers in these already-sensitive areas.

5. As the use of computers is a major portion of technological and family studies courses, easy access to the hardware is essential. Ideally, this would include several workstations in the classroom so that their use could be integrated fully into the daily work, with the class regularly divided between seat/lab work and computer work; as well, a computer lab offers the ability to introduce software and participate in large-group activities.

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2.4 HISTORY, GEOGRAPHY AND SOCIAL STUDIES
by Ivor Goodson and Marshall Mangan

2.4.1 THE EVOLUTION OF A RESEARCH DESIGN

In the introduction to our first Interim Report (Goodson, Mangan, and Rhea, 1989a), we stated that the basic methodological position of this project was to be built around the principles of "grounded theory" (Glaser and Strauss, 1967; Strauss and Corbin, 1990) and "illuminative evaluation" (Parlett and Hamilton, 1977). We summarized those principles as follows:

> Illuminative evaluation was developed explicitly within the context of the assessment of educational innovation. The authors point out that such innovative contexts do not lend themselves well to the traditional experimental paradigm, which requires predefined research hypotheses and strict control of independent variables. They offer a number of reasons why this is so, including: the ethical implications of manipulating educational settings and the people involved; the impossibility of controlling ongoing changes during the implementation of the innovative program; the risks of losing important relevant data not included in predefined objectives; and the insensitivity of large-scale projects "to local perturbations and unusual effects"....
>
> These criticisms of the experimental approach to assessment of educational innovation are quite pertinent to the present research setting.... It will not be possible within this setting to control, or even to specify, all of the relevant variables ahead of time. Instead, by a process of regular and intensive, yet non-intrusive observation, we expect central themes and crucial areas for further research to emerge during the early stages of our investigations. (Goodson, Mangan, and Rhea, 1989a, pp. 28-29)

The progress of the history and geography section of this project we think has borne out the value of this approach. During the two years of classroom observation, and even before they began, a number of unanticipated occurrences gave rise to modifications of our original research design. By remaining flexible and open to change, however, we have been able to turn these occurrences to advantage for the purposes of the project. In the end, we feel that they have yielded valuable evidence regarding patterns of technological innovation in the teaching of social science.

The first fundamental alteration to our research design occurred when the geography and history sections of the project, originally intended as two separate studies conducted by two Principal Investigators, had to be merged following the departure of one of the participants from the Faculty of Education. The similarities and differences which have emerged between the two disciplines, however, have added important detail to the fabric of the observational data collected; opportunism thereby rapidly phased into opportunity.

Approximately halfway through our period of observation, another important alteration took place, described in *Interim Report 3*:

> The project encountered a dilemma during the Fall of 1989. It was clear that one of the teachers who had been designated as a "primary" participant was not using computers in his class, and it seemed unlikely that he would begin soon. On the other hand, his "backup" teacher had become an enthusiastic computer user, developing some of the most sophisticated applications for his students, as well as for his own use ... .

> [However,] we did not wish to intervene by either encouraging greater computer use by this individual, nor by suggesting that he might like to drop out of the project ... . Beginning with the second term of the 1989-90 school year, we decided to include the backup teacher *as well as* the primary teacher in this school, in order to be able to track both a group of students which might not use computers in their social studies classes, and one which definitely would be using them ... . We feel that our flexible methodology has again shown its ability to accommodate mid-stream changes in the real-life situation which we are attempting to monitor. (Goodson and Mangan, 1989a, p. 85)

As it turned out, during the last semester of observation, the primary teacher identified above—Walter Harvey—did begin to incorporate computer use into his classes, with some interesting effects which will be discussed below.

If the flexibility of our research design has allowed us to respond well to the challenges of a situation in flux, it must also be noted that the changes we have made have created certain difficulties. For one thing, the fact that a total of five history and geography classes have been included in the last two semesters of observation, and the fact that these classes have tended to have the highest enrolments, has led to a situation in which over half the participating students are drawn from these classes. This may have had the effect of skewing some of the questionnaire analysis. We also felt it was important to monitor Walt's initial computer use closely, and therefore visited his classes frequently during the last semester of observation. This resulted in a slight oversampling of his class for the RIACPTS analysis (see Volume 3). As our methodology is essentially qualitative, however, we do not feel that these problems have outweighed the benefits of our basic approach to the study of classrooms.

The changes to our research design have not been confined to the configuration of participating classes and teachers, however. During the course of the project, the central themes of our research concentration have also undergone some significant shifts in emphasis, as Glaser and Strauss suggest they might. In part, these changes have been influenced by the fact that the authors of this section are also responsible for the identification and exploration of many of the over-arching themes in the introductory sections of previous Interim Reports. It is only natural that there should be some carry-over into our analysis of social studies from the work we have done in explicating those themes.

In our preliminary statement of research objectives (Goodson and Mangan, 1989), we identified a number of initial areas of interest. In this final Interim Report, it may be useful to review these and provide some assessment of our progress in evaluating them.

2.4.2 PROGRESS ON RESEARCH OBJECTIVES DEFINED EARLIER

> In our first Principal Investigators' report, we opened with the declaration that research into the use of computers in the classroom should remain open, at least initially, to the broadest possible conceptions of how computers might be integrated with the overall objectives of the history and social science curriculum. (Goodson and Mangan, 1989a, p. 88)

This has certainly remained an essential principle of our approach to the evaluation. In following that principle, however, our central emphasis has shifted somewhat. In our section on "existing theory", we provided an overview of the kinds of analytic categories developed by the UNCAL project in England (MacDonald et al. 1977). Elsewhere in that first Interim Report, the UNCAL typology had also been related to other forms of cognitive analysis used in evaluating classroom activity by a number of earlier researchers (see Goodson, Mangan, and Rhea, 1989a, pp. 23-26).

Our interest in these cognitive categories was eventually incorporated into the RIACPTS analysis (see Volume 3). As explained there, we encountered serious difficulties in operationalizing these categories, and in extracting any useful conclusions from their use. It is possible to point to examples of each level of activity in social studies classrooms. It is also worth noting that, on the whole, the RIACPTS coding indicated that the classes under observation evidenced greater levels of small-group and student-led activity than we might have been led to expect from the literature.

The shortcomings of this approach were not only practical, however. As we became familiar with the settings, and with the people working within those settings, it became more and more clear to us that the kinds of issues addressed by the use of these categories were not of primary importance to the teachers and students in history and geography. We began to realize that investigations into the level of cognitive functioning linked to classroom computer use are premature when researching and evaluating the early stages of an implementation project.

The introduction of computers presents fundamental challenges to the established cultures of teaching and the social construction of school subjects. These challenges must be resolved before any stable or mature form of classroom computing can be expected to emerge. Although most researchers—and indeed most teachers—regard the introduction of classroom computers as a technical process dominated by issues of equipment installation and teacher training, there are in fact deeper cultural issues at stake which must be addressed before an adequate understanding of the process is possible. This concern with the culture clash precipitated by classroom computing has become the central motif of our analysis.

As we observed teachers teaching, and as we listened to them and to their students during interviews, we began to perceive that their own priorities and concerns demanded that we place less emphasis on technical and cognitive issues, and a greater emphasis on the kinds of issues and questions we had defined toward the end of our section in the first Interim Report:

> How does the "subject subculture" and the social structure of the teaching corps affect this project? ... Are there signs that the introduction of this new technology has an impact on the social organization of the class, the school, or the curriculum? What forms does this take? What "side effects" are produced in terms of: students' general "computer literacy"; students' relationships with teachers; students' relationships with each other; and their abilities to pursue their own interests? (Goodson and Mangan, 1989, pp.91-92)

The sections which follow recap the development of research themes which have arisen from the pursuit of these questions over the lifetime of this project.

2.4.2.1 **The Range of Computer Application and Participation**

Over the duration of the project, participation in the implementation of computers was uneven across the teachers involved. At Brock, for instance, Chuck Grambling quickly developed several computer-related lessons; he also expressed interest and enthusiasm for educational computing in his interviews. Walter Harvey, however, did not take his class to the computer lab at all during the first two semesters of the project. During his early interviews, Walt expressed a dislike for administrative uses of computers, such as marks management, but remained open to instructional uses. He cited his involvement in numerous other school-related activities and responsibilities as his only reason for not implementing computer use this year. These same responsibilities had kept him from attending parts of the in-service training, leaving him at a further disadvantage in creating computer-related lesson plans.

Ed Thompson, however, who was originally designated a "backup" team member, was very enthusiastic, and spent a great deal of time in the lab, exploring the various software packages and developing sophisticated applications of the *Democalc* spreadsheet program. At the beginning of the spring term 1990, Ed spent so much class time in the computing lab that he felt his students had reached a point of burn-out or satiation with classroom computing.

This mix of participation and curricular emphases can be taken as a microcosm of the three most common forms of reaction to computer use which we have identified: co-option, adoption, and marginalization. In describing our desired approach to the implementation of computers in social studies classrooms, we suggested that

> ... the question is not "how can we fit computers into the curriculum?" but "what teaching problems might be addressed by using computers?". (Goodson and Mangan, 1989, p. 90)

Despite our wish that this be the basis for classroom computer use, however, we generally found that teachers conceptualized the project much more in terms of the first question. And yet, although most teachers saw this as their "task" during the project, their responses seemed to stem from an orientation to the latter question. In other words, unless the computers could be seen to solve important teaching problems, and to mesh with the teachers' situated understandings of correct or desirable practice, they were resisted, forestalled, or marginalized. Even among the history and geography teachers who adopted extensive computer use, a certain amount of doubt lingered on concerning the degree to which their professional problems were really understood by those who developed the computer systems.

This was also reflected in the kinds of software chosen for classroom use. Chuck Grambling, for instance, found the program *A Week in the Life of...* to be very relevant to his curriculum in "Society: Challenge and Change". In most classes, however, general purpose "tool" packages, such as the word processors or the spreadsheet program, were the most heavily used. Several teachers indicated that they felt there was a dearth of material which was both closely relevant to the social studies curriculum, and compatible with the ICONs. Ed attributed his wide-ranging use of software to this lack:

Ed: There are no secondary-school level programs on that machine, that are specifically oriented towards geography, OK? Now, you can say, "Well what about *Canadian Shield Railway*?" Well, *Canadian Shield Railway* is an elementary-school level program.... I really think that there will be some geography-oriented programs coming along, as soon as somebody realizes what we do in that subject area, but right now we're dealing with somebody's vision of what geography is, and not specific reference to what we're—to our courses of study. So we're having then to take things like *Democalc*, and the spreadsheets and the word processors, and the things we have like that, which are programs that are not specifically set up for geography, and use those. And so maybe that's why we're using the widest variety.

Elliot expressed similar sentiments:

Elliot: I guess I had a vision somewhere that a significant part of my class would spend a lot of time on the computers, down the road. So in that sense it really hasn't happened. And I'm not angry or disappointed or anything, I just, you know, think that's the reality of the situation and I think it also ties into what software's available and what courses I've been teaching.... The first two years I was on the program, the software that tended to be useful applied to courses I wasn't teaching at that particular time.

Interviewer: What sort of software are you looking for and what is unsatisfactory?

Elliot: Well primarily I'm looking for software that's geared to the particular courses I'm teaching. Now one of them, the main one's Canadian history at the junior level. And there's very little related to the subject matter within that course, as far as I can tell. The other area that I've seen materials but haven't had a chance to evaluate them, 'cause the ICON can't handle them or we have no money to buy them or a combination of both, what I would call western civilization, perhaps American history....

These quotes are extremely dense in their implications for software development in this subject area. They show that, Ministry policy proclamations notwithstanding, there is still a perception among some practitioners that the designers of OESS software do not understand, or are not responding to, the needs of the teachers in the field. These teachers seem to be saying that they would like to use curriculum-specific software if it was available, but that they are forced to use tool programs by a lack of such software.

Even so, the variety of applications within social science subjects can also be viewed in a positive light. It reflects the wide-ranging nature of the topics covered, and the kinds of assignments given in these classes. Such assignments frequently require independent research, report writing, and the graphic display of quantitative information—tasks which fit well with general-purpose computing tools.

2.4.2.2 The Classroom Environment

Volume 1 includes a section describing in some detail the location of the system components at Tecumseh. Although efforts were made to locate the ICON workstations where they would be most convenient for the participating teachers to use, the variations in the physical design of each classroom resulted in installations which were actually quite different from room to room. In the family studies classroom, for instance, a bench previously used for sewing machines provided a fairly convenient platform, complete with abundant power outlets. In the art room, what had been a supplies-storage room became a nicely separate, if somewhat cluttered, computer work area.

In the social studies classrooms, the workstations were installed at the back of each teacher's room. These rooms were already overcrowded, however, and especially in the geography room, there was virtually no workspace around the terminals. Compounding the crowding problem was the inadequate provision of furniture. At first, the workstations were placed on small tables, but these were frequently so narrow that the keyboards had to be held in users' laps when in use. Later, these tables were replaced with others which provided a bit more room and easier electrical connections. This computer furniture was removed over the summer, however, and again replaced with long tables which had been in use in one of the school's existing computer labs.

These frequent changes in the physical configuration of the computers in social-studies classrooms have acted to further complicate a situation which has never provided a truly supportive environment. Computers which lack convenient workspace, are cramped and uncomfortable to use, and which are frequently out of service while changes in furnishings are made, are not likely to become part of the everyday life of classrooms.

There are other implications of the situation at Tecumseh. If both the number of workstations available and the number of teachers trained to use them are limited, then their movements must be co-ordinated efficiently in order to avoid down-time. Otherwise, teachers end up in classrooms without computer resources, or computers sit idle in rooms where teachers have not been trained to use them.

These impediments to use also point to some of the hidden costs of a distributed computer network. Classroom computer installations involve much more than simply placing terminals in existing classrooms; they even involve more than the obvious needs for cabling, power supply and security. They imply a need for adequate space and appropriate furniture. Ideally, workstations should be placed in areas which are properly lit, and which allow for their use without disruption to other students. All of these things imply both direct expenditures and the allocation of other scarce resources. One radical solution, which has been tried in at least one school in Ontario (see Halton Bd. of Ed., 1989), is to literally design the school from the ground up to accommodate computers, and to have all teachers and students in the school participate in computer-integrated education. The pilot schools that have done this so far have had massive support from the computer industry in the way of contributed hardware and software, however. It is an open question whether public funding could support the full cost of building such schools, or even of converting existing schools to similar standards.

2.4.2.3 <u>Temporal Patterns of Computer Use</u>

The initial computer installation, and the in-service training of the primary group of teachers, took place at mid-year, during the winter of 1988-89. This meant that there was a summer break, and several attendant disruptions, between the end of the first semester of observation and the start of the second. When school reconvened in the fall, we noticed a distinct fall-off in the level of both use and enthusiasm at both schools.

At Tecumseh, we formed the impression that the history and geography teachers had some difficulty finding productive applications for their classes, and the teachers confirmed this. The nature of the cluster installation at their school presented problems of classroom organization. This exchange from the first feedback session can be viewed as a capsule summary:

Interviewer: You say you haven't used them much. Do you feel that the setup is inhibiting you from using them?

Harry: The location is, yes.

Elliot: Well, the setup in the sense that if you want to teach the whole class something, how do you provide hands-on experience for, in my case, twenty or thirty kids, when I've only got two or three terminals directly available?

Harry: It takes a week, almost, to introduce all of the kids in a class of thirty-six, like last year.

Problems such as these have led to a consensus among most teachers that a combination of a computing laboratory for introductory lessons, and a cluster installation for later practice and tool use, would be the best possible layout. It also suggests to us, however, that if introductory use is being inhibited by the cluster installation, it may be better to choose the lab in an either-or situation.

Even an improvement in the physical layout of the computers, however, will not resolve the problems associated with the seasonal cycle of use. This project provided a good example of the amount of work that has to be done with a school-wide network at the beginning and end of each school year. Hundreds of student accounts must be purged from the fileserver at year-end, and new ones added as the next year begins. Workspaces must be cleaned up, task spaces organized, files backed up, and other routine maintenance performed. If these tasks are allotted to teachers or others who start work on the first day of school, then the pressure of the manifold other tasks associated with these times will inevitably affect the availability and usefulness of the system. Ed Thompson worked hard, as a site administrator and as a geography teacher, to have his system ready for the first week of school. As he frequently pointed out, however, this was only made possible by using the spare period he was allotted as department head. Is it reasonable to expect a similar situation at other schools, or should arrangements be made to allocate these responsibilities to someone who will see that the system is maintained over the summer, and prepared for the beginning of each semester?

2.4.2.4 <u>Antecedent Subject Subcultures</u>

Our observations to date suggest that the subject subculture of high school social studies generally conceptualizes the curriculum as consisting of a body of factual knowledge to be imparted or transmitted to students through the agency of the teacher. We observed the widespread use of audio-visual aids in these courses, such as films, videotapes, maps, etc., as well as occasional field trips and co-operative projects. But the general pattern was one of "recitations" (made up of short lectures, reviews, and questioning of students), exercises, and tests. This contrasted with the more "practical" courses such as art, cooking, and drafting. In these courses, lectures were usually short, and student assessment was based more on the demonstration of a concrete skill or the production of artifacts, rather than on exams reflecting the acquisition of a repertoire of verbal knowledge.

The place of instructional computers in this subject subculture is, not surprisingly, different from the place they may have in the subcultures of art or technical studies. Early uses of the computers tended to consist very much of "translations" of earlier lesson plans. Teachers would show us, from time to time, an existing assignment and suggest enthusiastically that "this would be perfect to put on the computer."

In part, this was probably because teachers had neither the time nor the experience with the computer system to develop completely new lessons. Most computer exercises in the first part of the semester consisted of typing in existing notes, or using word processors instead of pens or typewriters to prepare reports. The conception of the course content as being largely a verbal or written body of knowledge is partly what made this form of transition possible. By contrast, art classes might be more likely to recognize the role of the medium in influencing the kind of message being transmitted, and might not attempt such a direct translation.

As later observations were to reveal, however, the tendency to transfer, rather than transform, existing pedagogy was not due simply to a lack of familiarity with the capabilities of the computer. Although the computer laboratory at Brock did show some evidence of encouraging more small-group activities, in general the subject subculture of social studies proved remarkably resistant to any deep alteration. This subculture is made up not only of conceptions of appropriate content, but also of appropriate teaching styles. The next section examines the challenge to these styles presented by computers.

2.4.2.5 Teaching Styles in Transition

A number of writers in the field of CAL have maintained that the most productive use of educational computers requires revised teaching styles which will maximize their desirable features, e.g., precision in calculating and formatting, individual pacing of instruction, opportunities for discovery learning, and non-judgemental patience in dealing with students (see, for instance, Papert, 1980; Pogrow, 1987; OTA, 1988). In most of the cases we have referred to above, it appears that computers have not yet opened up new areas of learning, but have acted more as new media for established course content.

When asked to characterize their own teaching styles, several of the teachers we interviewed chose the term "Socratic". We take this to mean that it is centred around a process of classroom questioning, in which students are exposed to material through reading or classroom demonstrations, and later asked to respond with short answers to a series of questions posed during a teacher-led review. Our on-site observations confirmed that this was a virtually uniform style of presentation among the participating history and geography teachers.

We asked these teachers directly whether they felt that computers posed a challenge to this style, and most replied that they did. The forms which they found that challenge took varied from teacher to teacher, however. As Ed Thompson said,

> I find that when you are in the lab and when you do try to teach using standard classroom procedure while the computers are still on, you might as well forget it.... You can't see who's gone to sleep and who's not paying attention and so on. So, I mean it's different that way, but again, it's just because you are trying to adapt a classroom, you know, Socratic method into a... something that isn't a classroom.... I wouldn't try to do that again. I would, what I would do is collect the data, have them analyze it and then take it back to the classroom and take it up. Now that's, you know, that's... just the normal process, I guess.

For this teacher, as for some others, issues of behavioural control are inextricably mixed with his pedagogical style. Having discovered the difficulty of maintaining control in the computer lab, he plans to alter his computer usage in order to maintain his established pedagogy. For other teachers, teaching style is embedded deeply in their self-concept, and even if they can see the desirability of change, they do not anticipate profound alterations for the sake of introducing computer-assisted learning.

Elliot: I'm not really sure how computers are going to fit in, yet.... In the back of my mind is that eventually the kids are going to be more into individual work or group work, when they get into current social issues.

Interviewer: Uh-huh.

Elliot: So at that point it might be easier. Class will be broken down into smaller groups and it might be more convenient to have them use the computer facilities....

Interviewer: But it's a kind of backup to the main business of the class which is....

Elliot: Yeah. And the main business has usually been defined by me and still focuses on me, as much as I sometimes think I'd like to get out of that central role. I find it easy to do.

Interviewer: Uh-huh. So you don't see that changing?

Elliot: I think after twenty years I've developed that role, or that role has been comfortable because of my personality. And I can't see myself turning into another kind of person for the sake of changing the classroom....

Interviewer: So I mean in that sense what you're saying is, I guess, that you feel you've got some handle on what you think that content should be and it's your task to define some tasks to get that content across.

Elliot: Essentially.

Interviewer: And that you don't really see a way of devolving that responsibility onto a program or a computer.

Elliot: No. Not right now.

Passages such as these should alert us to the fact that educational computing has a profound impact on the entire culture of a classroom, and that the problems of effective implementation are not technical ones only. Even where Ministry policy recognizes that a change in pedagogy is necessary to make the best use of computers, teachers are still subject to a range of pressures that reinforces the established subject subculture, and which supports the continuance of the existing pedagogy. To be truly effective, the implementation of educational computing may have to confront these pressures directly.

This should not be taken to suggest that social studies represents a recalcitrant and conservative area which is invulnerable to new approaches. Indeed, by the end of the first term, teachers such as Chuck Grambling were experimenting with several innovative lesson plans. One of these lessons, for instance, allowed students to use *Co-Co* to discuss sensitive topics of social mores anonymously through the computer network. Even here, however, the teacher maintained control over the nature of each subtopic and the time to be spent on it.

It may be that only time is required to achieve the modification of the subject subculture. Perhaps in twenty years, computers will be an accepted part of social studies classrooms. For the present, however, we should remain sensitive to the costs involved in this transition, and the retarding effects of these costs. It is true that students seemed generally excited and enthused by the lessons that were produced. They spontaneously proclaimed that using computers in this way was "neat", "fun", etc. It was also clear, however, that such lessons initially required more time and effort to prepare than either a conventional lecture by a history teacher, or a conventional painting session by an art teacher. They also exposed the teacher to more problems, both technical and organizational, as students struggled with the various stages of loading and running the program.

2.4.2.6 Variability in Antecedent Influences

At Tecumseh, the particular confluence of physical set-up, teaching styles, and subject subculture could be seen to produce a certain kind of result at that school. At Brock, on the other hand, although the subject subculture could be expected to be similar, the other ingredients are quite different. A different range of classroom experience, teaching approaches, and personal styles has combined with the configuration of the computing laboratory at Brock to produce different results for the implementation project.

The third term of observation was a good example. During this term, Chuck Grambling continued and expanded his use of the computing laboratory, incorporating a range of curricular software (especially *A Week in the Life of...*) as well as general-purpose packages such as *Co-Co.* Ed Thompson began his semester with an intensive week of computer use, which incorporated an integrated, problem-centred approach to a data-analysis exercise. Students were assigned to interrogate the database in *World Correlations*, extract certain data, transfer these to a private file, analyze them, and then write a report using a word processor. Walter Harvey continued to exclude computer use from his curriculum.

In the first case, Chuck had settled into a routine which he found comfortable and manageable. Chuck is one of the youngest and least experienced of the cohort, but this may actually be working to facilitate his incorporation of computers. He does not have a firmly entrenched approach to his subject, is more than willing to experiment.

> I leave everything open. I'm definitely very willing to change in variety of— changing things up a little bit or trying new—always looking for new strategies and techniques.

However, he is also quick to incorporate successful experiments as permanent parts of his teaching program. During the first semester of computer use, we observed several glitches in Chuck's laboratory sessions, which might have sufficiently flustered or embarrassed some others to discourage further use. He persevered, however, and eventually developed a number of lessons which dovetailed smoothly with his classroom presentations. One feature of his practice was the use of computer sessions as a motivational tool. He frequently scheduled them for Friday afternoons, as a way of holding students' attention when they are often distracted (or might otherwise be absent). In the case of this teacher, then, his subject, his teaching style, and the computer configuration in his school have combined to produce a satisfying experience for himself and his students.

Perhaps the most interesting illustration of the ways in which differing influences produce differing outcomes in this endeavour was Ed Thompson's experience. A devoted computer enthusiast who is also the site administrator, his lesson plan for the beginning of his second-semester class was worked out in great detail and implemented right at the beginning of the term. In many ways, however, it backfired. Student comments on the questionnaire, administered one week into the term, reflected some resentment against their virtual immersion in computer lessons:

> It is difficult and aggravating when you're unfamiliar with them and the class is so large the teacher is unable to give you necessary assistance.
>
> I took this course to study Canadian geography, not the use of computers.
>
> I find it a very impersonal way of teaching.... I would much rather be discussing the course subjects with the teacher and my classmates than sitting in front of a terminal.

Admittedly, by the time of the student interviews at the end of term, most of them had mellowed.

Student #1: At the beginning I didn't ... I thought it was ... I had a kind of biased opinion about using them but, kind of, after the time was over, I thought, that was okay. I didn't mind it.

Interviewer: 'Cause the comment that you wrote on the questionnaire indicated that you thought it was a little too much computer use and not enough geography at that time.

Student #1: I was, I was just being ... I don't know ... I was kind of mad at the teacher and stuff like that.

Interviewer: Well, how do think the other students in your class have reacted generally?

Student #2: I think they ... a lot of them reacted the same way as I did. At the beginning we were just kind of thrown into it, a lot of people weren't expecting it. The people ... a lot of people, they liked it, after a while. The first initial stage they weren't ... they were kind of ... unhappy.

Even so, Ed was somewhat chastened, and remarked that he would not repeat this lesson as originally configured.

> ... Maybe it would've ... if I hadn't got involved so quickly it might have at least given them the idea that there was something in this course other than computers. I think there were some people who thought we were going to spend the whole year on computers, the way we started. So that ... but really I think the key to changing it is just ... changing my approach to it, to the database rather than anything else. ... That'll come around.

There is a clear sense here of the necessity to learn from experience, and to progress through successive stages of familiarization and fluency in the use of information technology, and the appropriate pedagogy to accompany that use. In Ed's case, as well as Chuck's—indeed, for most teachers—their traditional position of authority might have been threatened by the fact that they did not have solutions for some of the problems they encountered. Flexibility and resourcefulness were required to deal with these situations gracefully. These are the qualities demanded of anyone who must make the transition from one culture to another.

The challenge, however, is not merely a personal one. It has to do with the transformation of the everyday activities of social studies classrooms. Those activities have a history and a rationale which is not accidental, but is itself the product of purposeful activity by generations of teachers and planners. The following sections represent the beginning of an analysis which addresses the kinds of transformation which social studies teachers are confronting as computers enter their classrooms.

2.4.2.7 The Culture of Computing

Computer use within the social sciences can be seen as itself forming a new subculture, which cuts across more traditional subject area boundaries. One of the ways in which this is apparent is that discussions of the appropriate role of classroom computers frequently throw the purposes of a social science education into sharper contrast, as revealed in this discussion from the first feedback session:

Harry: What are we there for? Are we there to teach the kids geography, or are we there to educate them? ...every kid, I think, on this earth is going to be involved in the use of computers at some point, certainly in Canada, in their working life... and maybe our job is to make them more computer literate, than to teach them geography.

Interviewer: That hasn't historically been your job, though. I mean, the job of the school historically has been to educate in a general sense, hasn't it?

Harry: Yes.

Ed: Right.

This exchange reflects the reciprocal influence of computer use vs. subject subculture. It is not only that computers are accommodated in different ways within different subject subcultures. It is also the case that computer use can itself become a priority which breaks down the former boundaries, and even the established purposes, of a subject-area speciality. This raises important policy questions as to whether such a breakdown is an intended or desirable effect.

The creative use of educational computers exacts a price from teachers, a price which some may feel they do not wish to pay, or that they are not being fairly compensated for. We have identified at least three possible forms of reaction:

- computers may be marginalized, with teachers consigning them to occasional use which is not well integrated into students' other learning experiences;
- computers may be incorporated into existing curricula as "just another A-V aid", an alternative medium of delivery for a proportion of the content which is seen as the subject matter; or
- there may in fact be profound effects on teachers' styles and the social organization of their classrooms, in which they recognize and embrace the potential for new kinds of learning which were not included in the traditional syllabus.

The third possibility seems to be what the Ministry intends, as indicated by the following quotes:

> - Computers allow students to work in groups to accomplish a variety of tasks that promote co-operation and provide meaningful questions for discussion....
> - Computers can help the teacher to move from the roles of authority figure and information provider to the roles of facilitator and consultant.
> - Computers can sometimes give students an increased measure of control over the pace of their learning. (Ont. Min. of Ed., 1988, p. 23)
> - All learners shall have opportunities to work individually, in pairs and in group learning situations using computer technology....
> - The individual shall be in control of the technology.
> - The arrangement of the technology shall promote the interactive involvement among learners and between the learner and the computer.
> (Ont. Min. of Ed., 1991, p. 18)

Whether this possibility can be realized, however, will depend on whether the context of classroom computing is recognized and addressed holistically. That context includes, but is not limited to: the traditions of the subject subculture; the backgrounds and personalities of the teachers; the expectations of Ministry officials, principals, and parents; and the reactions of students. It also includes the impact of other educational innovations which are taking place simultaneously, and which some teachers perceive as being of an even higher priority than computer implementation; specifically, the "de-streaming" of the transitional years of secondary study (see Cole, 1990, for a forceful statement of this concern).

In the end, the adoption of computers for classroom learning in social studies will depend upon the extent to which they are seen by teachers as congruent with their other commitments, both professional and personal. It is clear that incorporating computers as an effective learning resource requires major efforts on the part of teachers. As we have come to know the teachers participating in this project, it has become clear to us that, for each of them, teaching is much more than a job—it is a way of life. To understand the ways in which computers affect their teaching, then, we must attempt to understand how they affect their lives.

2.4.2.8 Teachers' Lives and Teaching Styles

Despite the inconvenience involved, all of the costs enumerated above could probably be born by a teaching staff, and a public, fully committed to the idea of computerized education, and willing to see teaching practices dramatically altered to accommodate it. Is this, however, a realistic expectation? For several of the social studies teachers (and probably for most teachers), their teaching style is intimately connected to both their educational philosophy and their personal self-image (Mangan and Goodson, 1990, pp. 94-96). Elliot Nance put it clearly when he said, "I can't see myself turning into another kind of person for the sake of changing the classroom."

This sort of resistance does not, to us, appear to be simple laziness or conservatism. Most participant teachers have expressed a willingness, even a desire, to change, if and when that change is shown to be necessary, constructive, and long-lasting. It would appear that some are not yet convinced that the form of computerized education involved in this project meets those criteria. This may be partly due to the experimental nature of the pilot project, and an unwillingness to change for something they see as ephemeral, but we believe it also bespeaks more fundamental and long-term problems. It may also be related to an uncertainty about the wishes of "external constituencies", notably parents, with regard to any changes in teaching style.

We have speculated before that the traditions of transmission-style pedagogy in high school social studies may work against the full integration of computers into social studies classrooms. What now seems to be clear is that this pedagogical tradition by itself is not an insurmountable obstacle. But when, within certain contexts, it is combined with problems related to the physical set-up of the computer system, and augmented by the resistance to change felt by teachers who have a tried-and-true teaching system, the costs of computer usage may come to outweigh the benefits, and it becomes likely that the computers will sit idle more than they will be used.

Harry: Don't come along and say that, "Hey, this is going to be the way you are going to teach from now on." I'm too old to change my ways. Hey what I've been doing, I think, has been working and if it ain't broke you don't fix it. Don't change simply for change's sake. Introduction of new ideas, great, we do it all the time, but don't force a whole pile of ... or one change totally onto us.

Comments such as this one illustrate the magnitude of the changes required if computers are to represent a genuine alteration in pedagogical styles, and in the culture of classrooms. One thing that seems certain is that it will take more than the introduction of technology to accomplish such a change.

2.4.3 CONCLUSION

The effects of teachers' personalities and teaching styles, subject subcultures, and the physical design of the computing environment can be seen to interact in ways which produce a range of effects and reactions in relation to educational computing in history and geography classrooms. The challenge for Ministry and Board policy-makers, as we see it, is to develop guidelines and practices which can accommodate this range, without imposing counter-productive strictures on the ways in which educational computing might be used. One thing that is clear from the variety of responses described is that teachers retain the primary control over what happens in their classrooms. This is probably as it should be, and will continue to be. The implication for computer policy, however, is that the needs and preferences of teachers must be accommodated if the enormous public expenditure on educational computing is to pay off for the people it was meant to benefit: the Province's students.

2.4.4 RECOMMENDATIONS

Although there is a wide range of software which can be applied within high school social studies classes, the use of "tool" software seems to predominate. This is unlikely to change, because it is directly linked to the nature of the subject and the kinds of classroom tasks generally assigned. In order to accommodate this fact:

1. Social studies teachers should be supplied with high-quality word processors, spreadsheets with graphing abilities, and "user-friendly" database packages.
2. These tools should be standardized to the greatest degree possible. If a single software package cannot be made standard, then at least a consistent user interface should be specified. Standardizing upon an integrated package such as *Microsoft-Works* might promote the ease of use even further.
3. Teachers should be thoroughly trained in the use of these tools, and provided with opportunities to develop productive applications of them.

Given that tool use predominates, there are still specific areas in which curricular software could be developed, or in which customized tools might be produced. Recent Ministry policy (Ontario Ministry of Education, 1991)suggests that subsidies will be continued for the development of software. We would suggest the following areas be explored:

4. A geographic database package, customized to fit into the Ontario senior geography curriculum, was seen as desirable by the teachers involved in this project.
5. There are potential applications for simulation programs, similar to *The Bartlett Saga* or *Decide, Your Excellency*, for the secondary history curriculum.
6. Social studies teachers from grades 10-12/OAC should be closely involved in the development of the kinds of packages described above.

Social studies classes are frequently among the largest and most crowded in a school. The insertion of computers into such classrooms can be unproductive, or even disruptive, unless the physical environment is taken into account. This implies:

7. Adequate space should be provided for each computer terminal. Space requirements include not only sufficient room for the workstation, but enough for surrounding work areas on which to put papers, books, etc. If collaborative work is to be encouraged, there must be room around each terminal for two or three students.

8. There should also be an adequate supportive infrastructure, which would include:
   a. Properly designed tables and chairs for each terminal;
   b. Adequate wiring, in terms of power outlets and cable routing which is safe and secure;
   c. If a Classroom printers are a necessity for tool programs to be used properly. These should have their own supporting furniture, and be placed for easy access and maintenance.
9. Ideally, a separate area connected or close to the classroom should be provided. Such an area would provide access for those using the computers, without either removing them entirely from contact with the classroom, or disrupting others.
10. All teachers in our project agreed that the best of all worlds would include both a computing laboratory with twenty to thirty workstations, and an in-class installation of three or four workstations, preferably connected to the same network.

The subject subculture of social studies has historically conceptualized the curriculum as a body of factual knowledge to be transmitted to students. The predominant teaching style has been described by teachers as "Socratic". To some extent, current Ministry efforts seem to be aimed at changing these concepts of curriculum and pedagogy to a more process-oriented, collaborative style. If computers are to assist in this process:

11. Teachers need specific training on the ways in which computers can assist in the implementation of collaborative learning styles.
12. Curriculum guidelines and evaluation practices must be brought into line with the goals of a revised pedagogy.
13. A greater degree of cross-curricular integration of educational technology needs to be encouraged. One way this could be done is by promoting multi-disciplinary projects which emphasize the use of computers as tools for organizing, analyzing, displaying, and reporting on research data and analytic themes.

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2.1 COMPUTERS FOR CURRICULAR AND INSTRUCTIONAL MANAGEMENT
by Allan Pitman

2.1.1 STATEMENT OF INTENT

In this Summative Report, the primary focus is on the changes in statement made by teachers about the uses they make of the ICON and other computer systems for their management tasks as they move from introduction to the system to experienced users. Attention is paid to the shifts in balance in concerns raised and enthusiasms expressed. The purpose of this report is to summarise an exploration of an analysis of teachers' shifts in interests and concerns, based on explicit discussions in which early positions are reintroduced for reflection by the teachers of their initial and subsequent positions.

2.1.2 METHODOLOGY

This Summary Report represents a review of the developing perspectives of the participating teachers as they adapted and changed in their interactions with the ICON system and other computers to which they had access. As such, it reprises in part descriptions and issues raised in *Interim Reports #2, #3, #4* and *#5* (Pitman, 1989a, 1990a, 1990b, 1991).

The purpose of the analysis presented here is to examine the text of teacher discussion about computer usage. From this analysis, comparisons are made to reexamine earlier transcripts and of interpretations as produced in the earlier documents.

The teachers involved in the study are vital to the interpretation of the findings of the project as it develops and is then summarized in a final report. Obviously, they are the original sources of the information, either through their reportage in interview or through our observation of their actions. They are also fundamental in validating that our understandings of their statements and actions make sense. By testing our assertions against the participating teachers' understandings it is intended to reach findings which are well grounded, even if not fully agreed to by all involved. Final responsibility for findings will rest with the Principal Investigator.

2.1.3 FUNDAMENTAL QUESTIONS

2.1.3.1 <u>What is the Importance of Initial Comfort with Computers?</u>

Teachers come to a computer usage project with a tremendous range of experience and of levels of comfort with the technology. Microcomputers of various makes and levels of sophistication are unevenly distributed throughout homes and schools. Some teachers have never used a computer, others are competent programmers, others possess a range of word processing and graphics skills.

2.1.3.2 <u>What is the Importance of Initial Induction/Workshop Sessions and of Continuing Technical Support as Usage is Taken Up?</u>

The Ontario Provincial Auditor (1988, p. 74) draws attention to the importance of implementation support. It is advocated that resource personnel act as Site Administrators, help teachers set up equipment, provide information about software, and offer training in the use of microcomputers and the integration of software into the curriculum. Until the time of the auditor's report, teacher training support at the Ministry level amounted to an expenditure of less than 81 cents per teacher for the 89 000 strong teacher force (p. 75).

That the need is there is suggested in Weygang's finding that, of Computer Studies teachers, only 9% completely agreed with the proposition that "I am able to modify programs successfully to the special needs of students" (Weygang, 1988; Appendix A). While this special interest group overall agreed with the statement there were one fifth of respondents who did not. It can be confidently hypothesised that the situation among the teacher body at large is not even as sanguine as this.

2.1.3.3 <u>What is the Importance of Portability and Compatibility of Machines, Programs and Files?</u>

The Ontario Provincial Auditor (1988, p. 70) draws attention to the fact that, at that time, only 26% of computers in Ontario schools were either one of the GEMS products, that is, either ICON/LEXICON or IBM/EDNET. Further, the great majority (67%) were cheaper, less powerful systems such as Apple IIs and Commodore PETs. His report concludes that

> It is, therefore, unlikely that the Ministry will ever achieve its original objective of complete standardization of computers. Hence the compatibility problem will remain (p. 70).

The problem is compounded in that ICON and EDNET are themselves incompatible (p. 68).

Weygang (1988) reports that computer studies teachers in 87 Ontario secondary schools felt overwhelmingly that "Teachers should be loaned a computer so they can prepare work at home", with 41% in complete agreement and 34% in strong agreement with the statement. The problem is also addressed by the Provincial Auditor:

> A further impediment is the lack of portability of GEMS. Without portable machines and diskettes, it is more difficult for Teachers and students to practice at home and become more comfortable with the technology (p. 77).

2.1.3.4 <u>What is the Importance of Accessability of Machines?</u>

In order to be used, the machines must be located in places where they are accessible when the potential users are themselves available. There are two standard arrangements for the location of ICON machines. The first is to concentrate them in a single laboratory, with the attendant advantage that a large number of students from the one class can use the machine concurrently. The other is to place terminals in classrooms, either singly or in clusters, with the advantage that access is always available. The two arrangements do of course imply different classroom strategies for their utilization during lesson time, but that is not the primary focus of this part of the project.

2.1.3.5 <u>What Programs do Teachers Use and How do They Use Them?</u>

The ICON system makes available to teachers a range of facilities including word processing, spreadsheets, marks manipulation and teaching packages. These packages range widely in their application to teacher practice, complexity and power. Some require a greater commitment of time and effort than others in order to learn to use them. Others such as *WordPerfect* (run under QDOS) can be relatively easily mastered at a basic level, but demand a great deal of time later if its full power is to be tapped.

2.1.3.6 <u>How Do Teachers' Perceptions and Requirements Change Over Time?</u>

It is reasonable to assume that the concerns of neophytes and those with some experience in the applications of a computer system will differ. Over the life of a project such as this, individuals will progress to various levels of "expert-ness" as they acquire knowledge and confidence in their use of the machine.

2.1.4 OBSERVATIONS

2.1.4.1 <u>Initial Comfort With Computers</u>

Familiarity with computers did not seem to particularly favour any of the subject areas involved in the study, nor to be biased overly according to gender. Prior to the project, one teacher had a Commodore 64 in his school office, another a Macintosh in her classroom. This person has worked in computer graphics in Toronto; since the project's second semester, the machine has been equipped with a laser printer.

Two of the women teachers reported having PCs at home, but stated that they rarely used them: their husbands used them for work. Two of the men had been using Commodore 64s at home for school work. The two teachers with Commodore 64s used them for maintaining their marks records. They and some other teachers used the computers to a limited extent for the production of classroom materials.

One teacher clearly was familiar with IBM machines, and had access to a larger computer at another location (which he was loath to use as it was "very, very advanced equipment"). One of the women had taken a programming course several years ago on a VAX and borrowed a Commodore 64 one summer to prepare course assignments. Some of the participants appear to have had virtually no previous computer operation experience.

Initial usage of the ICON system was frequently inefficient. This is not peculiar and is true of the adoption of any new way of working. It is nevertheless a vital element in the formation of attitudes to the efficacy of the system in terms of teachers' priorities. An example of change in work pattern is found in the way in which one teacher used the *IMark* facility. Marking of assignments was performed at home and erstwhile the scores were entered by hand into a record book. With the initial use of the computer, marks were then entered into the machine the next morning, so creating a parallel set. It was only after several assignments had been so handled that the work pattern changed so that the book was abandoned and the marked papers were used for direct entry into the data base.

An example of the relatively simple problems which can arise as real impediments is provided by one teacher who wanted to record half marks, but the program he was using—*Marks Manager* did not allow for this. He was unconvinced of the usefulness of other teachers' suggestions that he double scores or multiply them by ten. This set back his use of the program for over a year.

2.1.4.2 <u>Induction and Continued Support</u>

In this project, teachers have been supported by the understanding that the work they are doing is taken seriously by the Board, the University and the Ministry. This impression is conveyed by the recognition of the financial investment and consultancy support provided. The teachers involved have, for example, referred frequently to the importance of the provision of the computer consultant in the Board office, not only for the help the people in that position have been able to provide, but also simply the fact that it is there. The project staff from the university have been frequently in the schools, further contributing to the special nature of the enterprise.

The role of the support officer provided by the local school board is clearly vital to the adoption of computer system usage by the teachers concerned. The initial three and four day introductory sessions and the continuing presence of this resource were constant elements in explanations by teachers as to whether they were using the various programs available. There was a very clear reaction of upset and alarm when, at the end of the first school year, the particular person who they identified with this role was reassigned. They very quickly formed a similar relationship with his replacement.

2.1.4.3 Persistence in Using Multiple Systems and Compatibility

The inability of teachers to use the ICON system at home was early reported as an impediment to the speed with which a number of participants in the project both became familiar with some uses and explored others. Thus the full potential of the system was not being utilized as rapidly as might be the case. This was compounded for teachers in three ways by lack of total compatibility with the machines commonly held at home or already in classrooms. First, there was a perfectly understandable reluctance to transfer work when it involved total replication of effort. Second, the opportunity to explore the power of much of the software available was limited to times when access could be gained to an ICON machine. Third, two different sets of protocols often had to be learnt and remembered.

The wish was early expressed that the ICON computer was compatible with the systems at home so that work was able to be continued from one location to another. The board's resource officer at that time pointed out that *WordPerfect* was compatible with DOS systems, but that the ICON's *Editor* was not. One teacher at the initial workshop was concerned with the compatibility of disks between machines. Problems of compatibility led to another teacher persisting with the Commodore at home, as it was set up with the first half year's marks: the change was made to ICON for the 1989-90 school year as the *IMark* program was seen to be better than the one he was using. Here was a case of delayed transfer despite the recognition that the program quality was better and a positive incentive to change.

One teacher, who uses the ICON for test preparation and for general word processing, keeps two sets of records of student scores: one on the ICON and one on a computer in his room which is not compatible. This persisted for most of the project's life.

At Brock, the persistence by another teacher in using two machines can also be seen:

Ed: I've had the Commodore longer so a lot of this stuff that's on there is ... on a day to day basis. So when I want to go in and change something it's there and anything new I do on the ICON. Just because it helps me keep my finger into that system.

Not all multiple system use was as a consequence of incompatibility, however. It is worthy of note that Carl, the teacher who most articulately expressed the desirabilility in having every teacher networked to the school central office and to the board, also saw the advantage of a stand alone machine: "... maybe its the speed. I've wondered whether it was the anonymity ...."

Conversely, another teacher in the same school commented that, although a Commodore had been used some time before the project, "I haven't used it since". It should be noted here that the prior usage does not appear to have been extensive or particularly persistent: "I had forgotten most of it because I hadn't used it in some time."

Location is a variable in decisions as to whether to use the ICON or another system:

Barb: I just use the Mac [for management uses]. I get enough exercise without having to go up and down stairs to the computer.

The range of management uses is however being expanded by this teacher to include having set up a template for ordering materials.

2.1.4.4 Access to Computer Equipment

Teachers involved in the project are keen and interested. One of the major impediments to takeup and regular use is the interaction of teachers' available time and computer access. This was particularly a problem in the site in which the machines are housed in a laboratory setting. Departments at the school in which the laboratory arrangement is in place are moved, during the project, to request additional machines in classrooms. The value of the laboratory as a sole resource, initially endorsed by them, was after one year, being seriously questioned.

The location of the terminals has interrelated with teachers' developing preferences for laboratory or classroom placement. While the ideal seems to be a combination of both laboratory and two or three in reach classroom, given a choice teachers seem to prefer the (arbitrarily allocated) arrangement in their own situation.

Thus, at Tecumseh:

Harry: If I could have anything, I think I would always have three in the back of the room and I would have a Computer Lab within the school.

similarly,

Elliot: A lab situation plus three or four in the classroom is ideal. And I think that if I had to have one or the other I might prefer what I've got simply because they are mine. I don't have to compete for them.

However, within the same school,

Harry: It's so slow trying to get the whole class through one exercise when only three can do it at a time ... . I think I'd like the lab better, but it's probably got limitations too.

For one teacher for whom the placement of computer terminals was not convenient to his allocated classroom,

Elliot: ... although I haven't been able to use the computers for teaching, it has been getting extensive use from administrative use.

In the case of Brock, the site with the laboratory, future access is, as mentioned earlier, a potential problem in the minds of the participating teachers. With the facility opened to all teachers, the relatively easy timetabling of access could disappear. Nevertheless, as one teacher expressed it:

I can see pluses and minuses. I like the setup of the lab. I think I would like some computers in the classroom as well.

A recurring problem is the reliability of the system. The rueful comment of one teacher sums up the problem:

Betty: [The *IMark* program is] great, except just before midterm, the night I had to use it, it was down, it wouldn't work and no one was around so then I had all the marks in there and I just had to add a few, you know—a couple more marks for projects. And I came in after supper to do it, thinking it would take me half an hour. So I had to go home and manually do the whole thing that night. So I guess I've learned that you don't count on doing things at the last minute even though you think it's only half an hour's work.

The issue of system reliability has continued to be a concern not only in regard to classroom applications, then, but also for the management purposes of teachers:

Betty: We've had an electrical problem since last Wednesday. All the computers in the school are down except for the ones in the Resource Centre ... . I would have done [my final exam] on Friday but these were all down and the library ones were all in use ... . It's done now. But it's leaving it a bit late.

A continuing tension for the teacher participants throughout the project has been the fate of the ICON equipment at the end of the study. Until June, 1990, it was unknown what the Board's policy was to be with respect to whether the computers would remain in the project schools or would be dispersed across the district.

This assurance was clearly important to this teacher in dealing with the issue of persisting with two systems:

Ken: Because instead of putting [marks] on the 64 ... I'll put them on this [ICON] now instead. It is probably a little better than the one I've got—the 64.

At Brock, the laboratory arrangement continues to create a problematic situation for the school after the end of the project.

Ed: If we let everyone in there, it's going to destroy any access to the computer ... . It does seem to me that right now, since it's only restricted to the ten teachers that are involved in the project, that access is not a contentious issue.

This is exacerbated by the decision to return the room to the department which previously used it prior to the allocation of a new location for the laboratory.

2.1.4.5 <u>Programs Used</u>

As suggested earlier, the use of *WordPro* and of *IMark* has become fairly widespread in the preparation of tests and in the management of marks. The reasons include the added flexibility of time that teachers have when they are not dependent on waiting for a shared office secretary to reach their work: "I could do it in my own time, rather than before Christmas."

The report earlier probably gives the impression that once a teacher sees the virtues of a program such as *IMark* then conversion is complete. Not all uses tried are persisted with. For example, the storage of marks has not only not been adopted universally, but has been dropped in some cases. Thus:

Chuck: I did use (*IMark*) right at the very beginning of this whole program. I think that most people have to have a physical record of some sort to put every mark down as it comes in. You can't be sitting in front of a computer doing it. But if you have that, what good is it? To then put it all on a computer again, other than to give the kids a copy or something. But then they could look at my book, too. I just haven't got into it.

Whereas other teachers in the same school comment

Diane: *IMark*? Oh yes, I use it all the time. ... *IMark* is very good.
Interviewer: Do you trust it?
Diane: Yes I do. ... We had some questions about it when we first used it, but when you look at the arithmetic behind it, it's very straight forward. It works very well, and the kids like it. I don't know what it is about the printed word but whether its a lie or not students believe it, having it printed.

Other teachers choose not to use a computer based marks manager for very particular reasons. For example, one teacher explained why he preferred to keep his marks in a book:

Walt: At least this way also I can adjust more, when, as you go along, you think, change it. Whereas once you do it on a computer, you just forget about it afterwards. It's there and you go "Oh well, it's there, it's got to be right." You don't even second check it after a point.

The use of the computer for classroom materials such as handouts and overheads was much less mentioned than in earlier interviews. Two explanations can be proferred. Some teachers may in fact be using the computer less for these purposes. The second, and perhaps more likely, is that these are now routinized to the extent that while they have real effect in teacher work terms, they are not issues in the forefront of discussion. Other new applications have supplanted them in this.

One teacher who has done very little with other management applications did explicitly refer to these uses:

Diane: I have created several student worksheets, filling in the blank, worksheets for the programs that are down there. Creating some overheads with the bigger print. ... With that particular program generating memos and information sheets to other colleagues ... and being able to save them and retrieve them when I want.

There has been one further development in the applications being seen. One teacher has systematized ordering of classroom materials by setting up a template on her computer, which happens to be the alternative system she has available.

Barb: The only problem is that the warehouse stuff can't be put on the computer because it has to go on the other sheets now. We'll find if that is going to change ... .

Similarly, Elliot, a department chair, has commenced an inventory of materials. By putting time into this function, he is confident that tracking items and being able to make more informed future purchases will be possible.

2.1.4.6 Perceptions and Requirement Changes

The teachers in the project are using the ICON system, but in widely varying ways. One of the most striking observations has been the extent to which, for some teachers, the organizational aspects of their work has been affected by the power of computer use. In particular, *IMark* and *WPro* have been extensively employed. Teachers have been prepared to suffer a degree of inconvenience and investment of time for the later payoff of marks preparation and reportage.

Teachers reported using the computers for these organizational/ administrative purposes for about one to two hours per week. The applications ranged across keeping class marks (*IMark*), maintaining observational records (*WPro*), developing departmental inventory (*WPro* and

Microsoft Works), writing departmental agendas and memoranda (*WPro*), maintaining interschool sporting schedules and statistics (*Watfile* and *Democalc*), and preparation of notices for school activities (using a Macintosh as well as ICON).

The applications were very teacher specific, reflecting the differing ways in which decisions were made as to the value in return for time expended in gaining competence with the various programs. In part, these decisions seem to be related to the requirements and traditions of the subject groups and in part to the availability and previous use of other systems.

The issue of return for effort expended is a crucial one, as a consideration of *IMark* and its takeup will illustrate. As Harry Thorne, who only came to use *IMark* in the 1990-91 school year noted in his journal in September:

"I hope this saves time later. Wish I had taken Typing."

and in the following January, when drawing off the final marks for the semester:

"This does save time now!"

The value of *IMark* was not just seen in terms of time efficiency, however. Betty noted in a journal entry that it "... saved time. Students like the printout of marks breakdown." Later she observed that it "saves a lot of time" and was "more accurate". The same participant noted at another time that the program enabled her to have

"... entered marks and calculated cumulative average for [an] early warning report."

A further motivator for teachers to use the ICON for these purposes is the quality of a finished piece. Thus, when using *WPro*, for example, the comment was frequently made that the product was "more professional looking." By the same token usage did not persist when the quality of finished product was not up to expectation: one teacher observed that the *Spectricon* graphics and the seeing colour output obtained was such that she was "unhappy with the quality of printing." There is no record of that teacher returning to the program, although she continued to use the ICON for assignment writing and notices.

Even within the participant group there was not universal enrapturement with the role of the computer in general, over and above the particularities of ICON. One teacher was antagonistic to the effect of evaluation of using computers for the presentation of tests to children, along with the tendency away from extended response tasks likely to be involved. This is not to suggest that he did not use the computer system: he would not use it for this function however as he saw it as potentially deleterious to good practice. Another persisted with manually prepared student results and reports as he firmly believed that the hand-written report carried a humane quality which his students appreciated, which would be lost with the use of the computer. Again, this teacher did use the computer for student work, but not for these management purposes.

Two of the teacher group expressed worries early in the project about the possibility of the system being a vehicle for administrative surveillance. One concern was that the computer could be used to track usage—indeed, one teacher thought that the display of the time indicated this. A second was concerned with the monitoring of out of hours usage of the system—an irony, given the concern of the Provincial Auditor that such access was difficult.

A related concern, stated by two teachers, was that students could gain access to marks held on file. The issue is generalizable to confidentiality from other teachers and from administrators. Assurances were given of the confidentiality and security of files.

It is of interest to note that this was an early concern, sufficient to be proffered without prompting; by the latter stages not one, even when queried and, in the above cases, able to reflect on their early concerns, saw the surveillance and confidentiality issues as problems.

In an earlier report I drew attention to the heightened interaction between teachers involved in the RUCCUS project.

The teachers involved in the project have interacted with each other and with other teachers in their buildings in ways which differ from their earlier experiences. For example, in order to deal with difficulties in learning procedures and to deal with system problems, teachers in quite diverse departments have exchanged expertise and shared activities which would not have arisen outside the project. Within departments, some participants have introduced other members to the computer and have assumed elements of a collegial professional development role. The extent to which this would have occurred in a different set of circumstances must be considered problematic.

The intrusion of computers as means of information storage, processing and communication into other facets of life is becoming more evident. Thus, as one teacher involved in a service organization pointed out,

Carl: That's all computerized now, with just these old fax machines to link us—all branches together ... . No man's an island kind of thing. I think you're affected by everything you do.

Within the school, at Tecumseh, a scanner for multiple choice paper reading has just been purchased;

Harry: So that might be a distinct possibility that we put a lot of multiple choice on there and then when you want to set up a test, or you could pull the ones you want out. I can see that coming. It wasn't a whole ... well it had some use before but when you got the scanner and the possibility of using multiple choice on almost all your tests is there, then you know you could use that sort of thing. Because when you make only one exam up a year at the end and that's the only time you really use a lot of multiple choice it is really not worth it but if you are going to use them on a continuous basis it makes it work.

Interestingly, only the one teacher mentioned the purchase of the scanner at the time of its purchase and none have reported having used it.

Another aspect of the social context within schools is the attitudes held about ICONs by peers, in particular those in the computer studies area.

Harry: I think there has to be some education done too as far as the computer people in the school are concerned. They still have a definite hardening towards ICONs in the school system. You talk to the computer people around here and "ICONs ugh!" I think the original ICONs were not very powerful. Not very good, whatever. And they feel they don't know the new breed of ICONS so it is really ignorance on their part, and I think they were turned off them originally and they are not willing to even listen to anything now.

2.1.5 SUMMARY

As observed in *Interim Report #3,* the ways in which teachers have taken up aspects of the ICON system's potential continue to diverge. The reasons for this can be traced in part to the background they brought to the project, including the extent with which they have committed work to another computer. Another is the subject with which they are involved. While I have not made this explicit in the reportage, clearly the types of assessment which affect the convenience of using the computer for test preparation and mark storage are to an extent subject related. Third, perceived gain for time invested is an important determinant in how the machines are used. Linked to this aspect has been uncertainty up until recently as to the fate of the machines at the end of the project. The location of the ICONs and accessibility to other machines is a powerful influence or decisions as to choice of system.

An intangible is the extent to which the particularities of this project and its organization, with supportive systems both through the Board and the university staff have affected the modes and amount of takeup of the ICON by participating teachers.

There has been a remarkable maintenance of enthusiasm for the computer applications among the teachers involved in the project to date. Of particular interest is the manner in which there is relatively little discussion in the interview material in the later stages of the project about the classroom preparation function (overheads and handouts). Rather, they were more concerned with the applicability or otherwise of computers to their assessment development and marks storage. The diaries maintained by teachers over the final months do indicate that, for some, the use was nearly exclusively organizational in the marking and test or assignment preparation areas. Others were overwhelmingly using the computer for inventory, for sports scheduling and other school activity promotion.

2.1.6 RECOMMENDATIONS

A) Visible support should be provided at the school board district and regional levels with:
   i) Board personnel to provide both practical support in teacher professional development and technical assistance. [The appointment of such support personnel provide an importance indicator to teachers of the importance attached, by the Boards and the province, to their growing computer competency.]
   ii) A school-based "site manager" who can act as a contact front for district and provincial personnel and can provide basic maintenance and informal professional development, and develop on-site support networks between teachers.

B) Careful attention should be given to the development of professional development models which:
   i) Recognize the different perceived and real needs as teachers become more accustomed to the usage of computers for management purposes.
   ii) Recognize different teacher backgrounds with respect to the interrelationship of the types of software available for management purposes and:
      a) their applicability (or not) in the delivery of content in specific subject areas.
      b) the assumptions about computers which teachers bring, often associated with the cultures of the subject disciplines.
   iii) Incorporate, among other delivery methods, workshops providing relatively small amounts of new information and skill acquisition, which require:
      a) prompt later application in both a modelled situation and a second application relevant to the individual.
      b) a follow-up workshop within two to three weeks.

C) Information flows to "site managers", teachers and school administrators should be facilitated with respect to:
   i) software information
   ii) sources of funding for purchase of software
D) Steps should be taken now to facilitate the easy transfer of data and information between programs and machines used by teachers and those used for school and district administrative purposes. These concerns should be addressed at this early stage of the computerization of student records, curricular details and purchase ordering procedures, among other applications.
E) Guidelines for confidentiality and access to files by professional peers and supervisory officers should be considered. While there is a good deal of trust exhibited by users in this regard, the potential for difficulties is real as computerized record keeping in networked systems becomes more common place.

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2.2 THE APPLICATION OF ELECTRONIC SPREADSHEETS ACROSS THE CURRICULUM

by John Rutledge and Valerie Rhea

2.2.1 DATA SOURCES

The data for this summative report were collected by the research team during the entire project period, undertaken during the 1989-1991 school years. The data primarily consist of reports of classroom visitations, and transcribed interview results with both teachers and students. Additional data are taken from notes made during a full-day meetings with the teachers involved in the project, as well as visits to the school made by the Principal Investigator.

2.2.2 ACTIVITIES PRIOR TO THIS REPORT

As outlined in *Interim Reports #1, #2, #3, #4* and *#5* (Rutledge, 1989a; 1989b; 1990a; 1990b; Rutledge and Rhea, 1991), activities included the installation of hardware, the initial training of teachers, the sorting out of hardware and software problems, and the introduction of electronic spreadsheets into the classroom. *Interim Report #3* cited various successes in increased productivity in terms of the time needed to complete assignments. Also reported in *Interim Report #3* is the fact that teachers using the electronic spreadsheet were modifying their curricula in terms of adding topics, deleting topics, and expanding topics. *Interim Report #4* included samples of student work. These examples have also been included in this final report (see section 2.2.4.2).

Curricular changes were accompanied by additional teacher effort. Time was spent working on the computers preparing assignments, planning methods of introducing the hardware and software to the students, and planning class presentations that involved the curriculum-based use of the technology.

2.2.3 ANALYSIS OF SPREADSHEET APPLICATIONS

2.2.3.1 <u>Cognitive Skill Levels</u>

2.2.3.1.1 *UNCAL Typology*

Before reporting on data collected from the most recent term, it is appropriate to examine the different tasks that are generally accepted as being appropriate for the electronic spreadsheet. According to the typology of the British UNCAL project (MacDonald et al., 1977), there are four curricular paradigms, which categorize student computer assisted learning (CAL), namely:

a) **Instructional** CAL involving drill, practice and tutorial activities.
b) **Revelatory** CAL utilizing simulations and "trial-and-error" exercises.
c) **Conjectural** CAL relating to the creation of "new" knowledge.
d) **Emancipatory** CAL encompassing activities that free individuals from routine, time-consuming tasks.

Following the summary of Bloom's cognitive taxonomic model given below, the use of spreadsheets will be analyzed in light of these two typologies.

2.2.3.1.2 *Bloom's Taxonomy*

The use of spreadsheets can also be associated with the four upper levels of Bloom's taxonomy (Bloom et al., 1956/1972). Each of the categories listed below involve the use of the same tool for students, but are associated with increasingly higher levels of thinking and learning, as they relate to the use of spreadsheets in particular:

a) **Application** Enter data and print a numerical and/or graphical report.
b) **Analysis** Enter data, compute calculations, print reports.
c) **Synthesis** Enter data, compute calculations, analyze data, examine cause and effect, make predictions, discuss "what if's".
d) **Evaluation** Perform a simulation, modify parameters, experiment with different data, discuss impact of the parameters involved, reach conclusions, develop or refine a model, develop recommendations or guidelines, reach decisions.

2.2.3.1.3 *Cognitive Levels Observed*

The initial successes reported in *Interim Reports #3* and *#4* (Rutledge, 1990a; 1990b) have been duplicated but not extended a great deal by many participating teachers, with the exception of senior geography and electronics students, as will be described below. The use of spreadsheets can be seen as **emancipatory** (MacDonald, et al., 1977) for students, as it can save time, thereby freeing students from inauthentic learning, as this student said:

Interviewer: Did he use *Democalc* at all, with the spreadsheet, with rows and columns? Did you use that one?
Student #1: Yeah we did that too, yeah that was good too, yeah.
Interviewer: It was? Did you find it difficult to use that for graphing or anything?
Student #1: No. It was easy once he explained it, to pick up on.
Interviewer: Right.
Student #1: But yeah that was good. I liked that.
Interviewer: Would you prefer to do graphs by hand or would you prefer to do them...?
Student #1: No, like that.
Interviewer: Okay.
Student #1: That's the thing with it, either you could have read books or done it this way and this way is a lot better. It's faster.

These successes involved spreadsheet usage that can be classified as fitting into either **Application** or **Analysis** as listed above (Bloom, et al., 1956/1972). These included a variety of mining reports/graphs, graphs to analyze diets, and spreadsheets to examine series circuit electrical properties. In addition to this, in the last year of the project, some senior electronics and geography students were observed to operate at the higher levels of **Synthesis** and **Evaluation** in their assignments as they used *Democalc* to analyze their data, examine cause and effect, to reach conclusions, and to experiment with different data.

When interviewed, students frequently referred to the "graphing assignment". Peer training occurred but was frequently oriented towards "getting the data in" and "printing the graph". Although students were generally pleased with their work and the speed with which it could be done, there was little overall evidence of a higher-level learning activity occurring. Several of the assignments involved the use of the spreadsheet as part of a large project, the "graphing part".

At the end of the project some teachers had not introduced the spreadsheet into their classes, some had given assignments that accomplished data entry objectives, and some attempted to achieve higher-level objectives involving greater thinking and skills requiring **Synthesis** and

Evaluation. During the project, only two teachers reached these highest learning and thinking levels with their students. The teachers themselves are aware of this difference, and are varying their plans for future classes in this regard, as can be seen in the following quotations:

Diane: And I never got [*Democalc*] to the point where I felt comfortable enough to use it with the students, okay, and that was just a time factor and that's really too bad, that's the way it is.

Interviewer: What do the kids use *Democalc* for?

Harry: For drawing, mainly for drawing their graphs and setting up their charts and stuff like that.

This summary note, recorded during a feedback session, concerns Ed Thompson, who had made frequent use of the spreadsheet with several grade levels since the beginning of the project:

> [He] admitted that his experiments with spreadsheets and databases had not produced the kinds of analysis skills which he had hoped they would. Rather, his students were concerned to get through the assignment quickly by learning how to manipulate the software to produce the desired results.

In the last two terms, some teachers made a conscious effort to involve both themselves and their students with higher cognitive levels of thinking when using the electronic spreadsheet. Our observations suggest that as there may be a direct correlation between the level of use by the teachers and the cognitive skill levels attained by students while using spreadsheets, levels of use will be tracked in the following sections.

2.2.3.2 Levels of Use of Spreadsheets

2.2.3.2.1 *CBAM Typology*

While the UNCAL typology (MacDonald, et al., 1977) is useful for analysis of level of cognitive use of computers by **students**, the **Concerns-Based Adoption Model** (CBAM) (Hall & Loucks, 1977) helps us to understand the levels of use adopted by the participating **teachers** in using this innovation. It focuses on the behaviours of individuals as they approach and use an innovation. In some cases, this use has increased throughout the course of the project, while in others the level has remained stable. The Levels of Use definitions put forward by Hall and Loucks can be summarized as follows:

0. Nonuse State in which the user has little or no knowledge of the innovation, and is doing nothing toward becoming involved.

1. Orientation State in which the use has recently acquired or is acquiring information about the innovation and/or has recently explored or is exploring its value orientation and its demands upon user and user system.

2. Preparation State in which the user is preparing for first use of the innovation.

3.Mechanical Use State in which the user focuses most effort on the short-term, day-to-day use of the innovation with little time for reflection. The user is primarily engaged in a stepwise attempt to master the tasks required to use the innovation, often resulting in disjointed and superficial use.

4. **Routine**	Use of the innovation is stabilized. Few, if any, changes are being made in ongoing use. Little preparation or thought is being given to improving innovation use or its consequences.
4b. **Refinement**	State in which the user varies the use of the innovation to increase the impact on clients within the immediate sphere of influence. Variations are based on knowledge of both short and long term consequences.
5. **Integration**	State in which the user is combining own efforts to use the innovation with related activities of colleagues to achieve a collective impact on clients within their common sphere of influence.
6. **Renewal**	State in which the user reevaluates the quality of use of the innovation, seeks major modification of or alternatives to present innovation to achieve increased impact, examines new developments in the field, and explores new goals for self and the system.

2.2.3.2.2 *Levels of Use Observed*

Within the scope of this portion of our project dealing with spreadsheets across the curriculum, we can identify teachers in most of the above-listed stages. While all of the teachers received a brief introduction to *Democalc* during the initial training sessions, enough time has passed that this can no longer be considered *recent* acquisition of information about the innovation. Some teachers who have not used the spreadsheet with their students must therefore be assigned to the **Nonuse** category at this time. The progress of others during the course of the project, however, can be tracked within this CBAM categorization system. Several teachers are presently in the **Preparation** stage, where they are familiar with the program, and they recognize the benefits of using a spreadsheet in their subject area, but have not yet taken the step to begin to use it with their students. The teachers reported that they have not yet done so for a variety of reasons, the most common one being a lack of time. As Diane said:

> I think that the spreadsheet would've been one more thing that I think I would've used more. Perhaps even with the nursing students and when we do diets, we do diet therapy and I think that would be, you know changing just so they could see that when you do change, for example, a food in a diet that it does make a difference in sodium content of the diet, or it does make so that it would automatically adjust. I can see that, with time, I can see using it for that sort of thing.

Harry was observed to progress very quickly through the first three stages, establishing a **Routine** pattern of use for *Democalc*, using it solely for a graphing assignment with grade 9 geography students as a part of a independent study. This has now been done with every class of grade 9 students throughout all five terms of observation in this project. As he was satisfied with the educational uses of it, and the reactions of the students, he plans to continue to use it in this fashion in the future. The positive reactions of the students, which are part of the reason the teacher has remained at the **Routine** stage, can be heard in this typical student's voice:

Interviewer: What about in [your geography] class, what have you done?
Student #2: We've done graphs on it. He basically showed us how to use it.

Interviewer: This was using *Democalc*, the graphing?
Student #2: Yeah.
Interviewer: Yeah, the spreadsheet? Okay.
Student #2: And we did, we had to do a project, this mandatory project we had halfway through the term and we had to do graphs and everything, like we had to do graphs and it had to be on the computer.
Interviewer: Oh. What did you think of that?
Student #2: Well it was a lot easier.
Interviewer: It was easier, okay.
Student #2: Oh yeah, 'cause all you do is put the numbers in and hit a button and there it was.
Interviewer: So if you had a choice in the future and you had to do graphs or something would you...?
Student #2: Oh, I'd do it on the computer.
Interviewer: You would do it on the computer, okay. You thought it was a time-saver?
Student #2: Yeah. And it looks a lot better.
Interviewer: Okay, so the appearance was worthwhile?
Student #2: The appearance looked great.

Ed, a geography teacher and Ken, an electronics teacher, achieved higher levels of use of spreadsheets than some of the other participating teachers. As these teachers have been observed to refine, integrate and renew their uses of the spreadsheet, both of these teachers have reached the top CBAM level of use, **Renewal**. Both of these teachers developed their use of spreadsheets beyond the capabilities of *Democalc* for their senior students, and are experimenting with more complex spreadsheet programs, as was anticipated by this Principal Investigator. These two fieldnote extracts illustrate this phenomenon:

> Ken said he now feels very comfortable with the hardware and software in the lab, because he knows what it will and will not do. He seems to like spreadsheets, as many electronics applications involve plugging different values into a set of formulas. He said he now knows the limitations of *Democalc*, and no longer tries to use it for things beyond its capabilities. If he needs greater sophistication, he moves "up" to [the spreadsheet component of] *Microsoft Works*.
>
> Ed said that he was having problems using *Microsoft Works* on the network. He said that he decided to use it because he needed a spreadsheet with greater capabilities than *Democalc*. He said he hasn't decided whether he will transfer everything over to *Works* or not. He still feels more comfortable with *Democalc* and *Watfile*.

These teachers have still further plans for the use of spreadsheets in their curriculum. As the electronics teacher discussed in a recent interview:

Ken: I will probably use *Democalc* a lot more.
Interviewer: For what kind of things?
Ken: For some of the classes. You can especially with the grade twelve AC theory there are a lot of things we can do on *Democalc* that will take us into that, because we do have trouble giving labs in AC theory that are meaningful and yet aren't time consuming.

2.2.4 **RESULTS**

2.2.4.1 Specific Action Taken During This Reporting Period

In addition to the specific information included in the discussion of cognitive levels and levels of use, there have been other, more general, activities that teachers have undertaken regarding *Democalc* during the last terms, which should be mentioned at this time. Discussions between the Principal Investigators, Research Officers, and teachers involved in the project were held both at the February 1990 workshop and informally at the ECOO (Educational Computing Organization of Ontario) conferences in April 1990 and May 1991. Through these discussions, it became clear that although the initial training given to the teachers covered the function of the spreadsheet program in terms of data types, formula manipulation, and program capability, the electrical/electronic teachers at both sites had not yet applied the capabilities to advanced topics in their specific subject area.

As a result of this realization, this Principal Investigator demonstrated to these teachers how a spreadsheet program might apply to the courses which they were teaching. Examples involving both DC and AC circuit analysis were successfully demonstrated to the electronics teachers. Ken was particularly pleased with the new ideas he had received, including examples of how *Democalc* could be used to solve Series and Parallel circuits, and said that he would have never thought that up on his own. One week later the teacher commented that he was quite excited about the possibilities for the entire course involving AC circuit analysis when integrated with a spreadsheet.

Further developments on this were made in the final term of observations, with the electronics teacher finally achieving greater success with the use of *Democalc* in his program. His greater level of satisfaction can be heard in the following interview extract:

Ken: Okay, *Democalc* [was] used on two different occasions, and that works well, but I've used this pretty well with the advanced level students in the class. I did one with series circuits and one with parallel circuit where they've, I've started the problem, I've done the first two columns, and they've completed the series one and then gone on to the parallel. It's a nice system because you can go back in and check exactly what they've done, by looking at the formulas they've used in the blocks and that's, that was really, that's a good exercise.

Interviewer: Now how would you have done that in the regular classroom, how would you've handled that, would you just do...?

Ken: A series of assignments.

Interviewer: And that way...?

Ken: They do a practical type thing in the class, but I want them to do that because they're getting familiar with meters and how to use meters and what have you. But the actual problems, in fact—it when they're all through and they can change the value of one resistor and all the answers come up immediately, they realize just what a computer can do because they've gone through the exercise and taken a half an hour or three quarters to solve some of the individual problems.

Interviewer: So that way it saves time for them?

Ken: Yeah and they probably see faster, they probably see the relationships faster. That's been a good exercise.

The conclusion of this quotation also hints at the higher level of cognitive attainment with the use of *Democalc* discussed in a previous section of this report. Examples of student work demonstrating several of these levels can be found in the following section.

2.2.4.2 Examples of Student Work

Figure 2.9: Voltage-Resistance Pie Graph

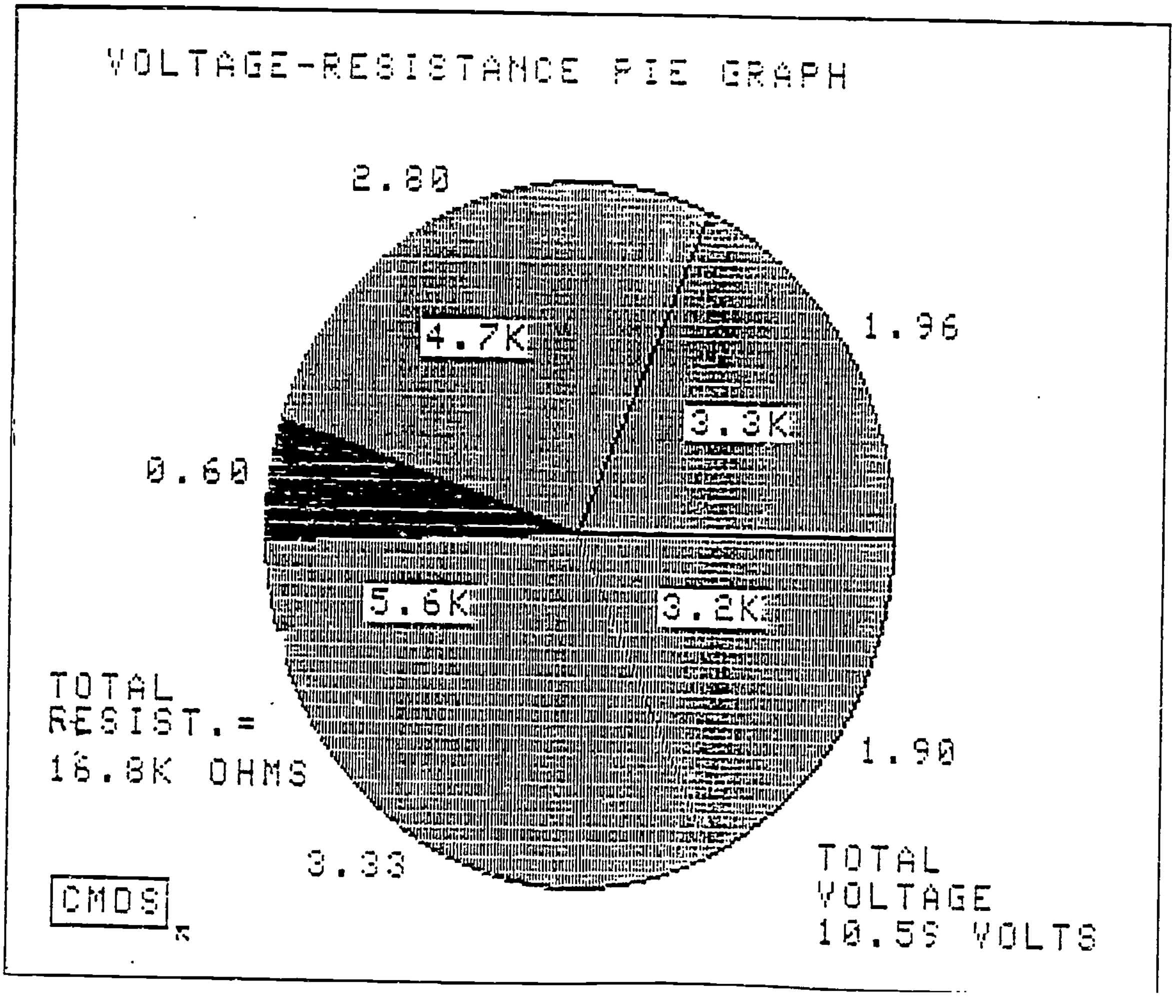


Figure 2.10: Population Density—Western Europe

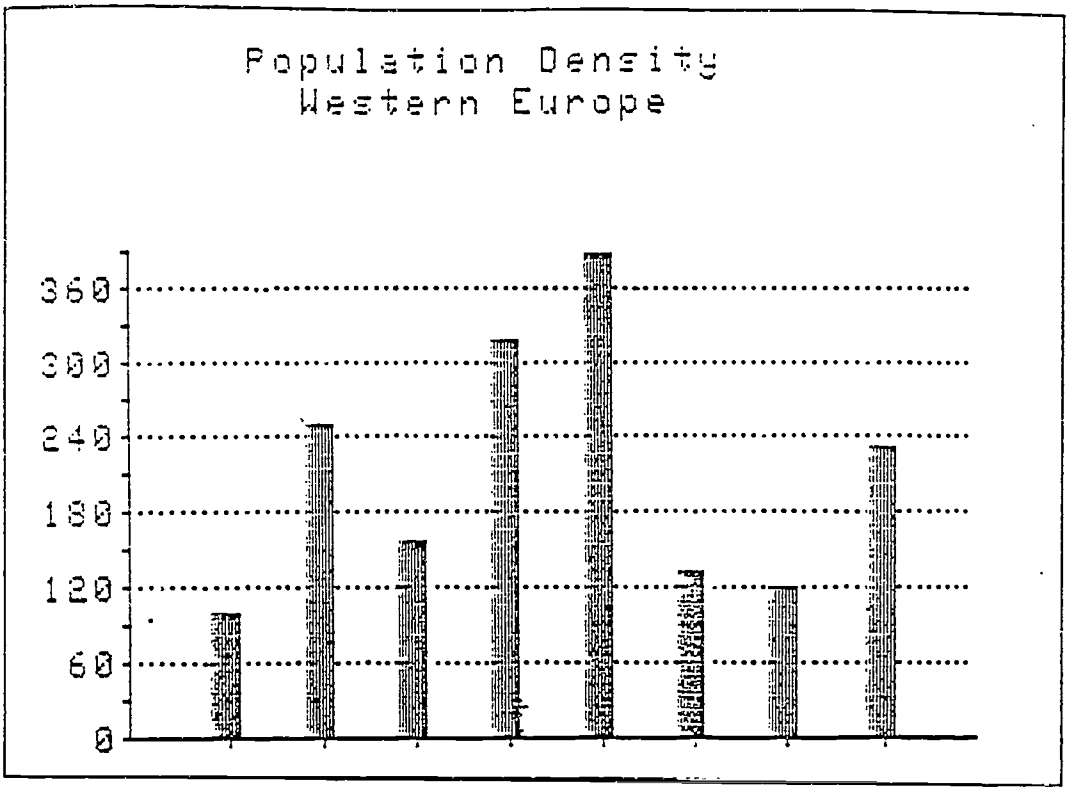


Figure 2.11: Population Sizes

Population sizes

REGION NAME	AREA (KM2)	POPULATION (MILLIONS)	POPULATION DEN. #/KM2
WESTERN EUROPE	1263000.00	218.40	173
FRANCE	547000.00	53.9	98.54
GERMANY W.	249000	61.7	247.79
GERMANY E.	108000	16.8	155.56
BELGIUM	31000	9.9	319.35
NETHERLANDS	37000	14.3	386.49
LUXEMBURG	3000	0.4	133.33
DENMARK	43000	5.1	118.60
UNITED KINGDOM	245000	56.3	229.80
CANADA	9976000	24.3	2.44
ONTARIO	1068582	8.62	8.07
QUEBEC	1540680	6.438	4.18
N.W.T.	3379684	0.045	0.01
USA	9363000	230.1	24.58
USSR	22402000	267.7	11.95
CHINA	9597000	1007.8	105.01

Figure 2.12: Production of Non-Metallic Minerals in Ontario

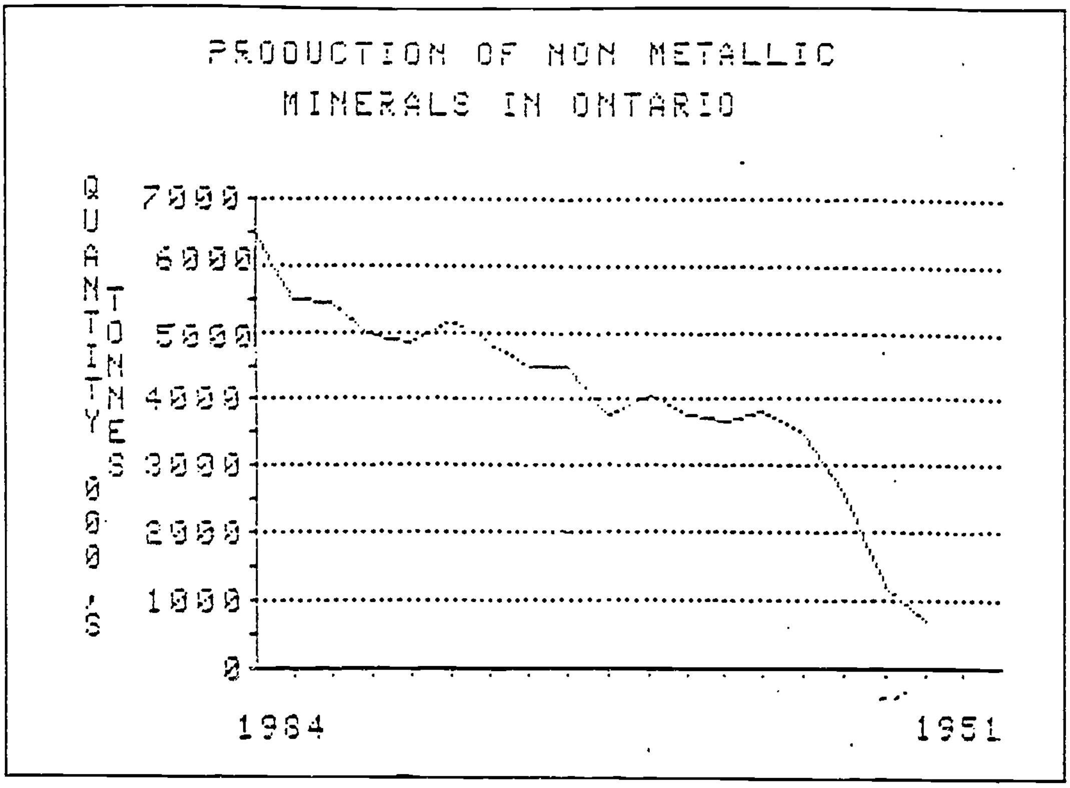
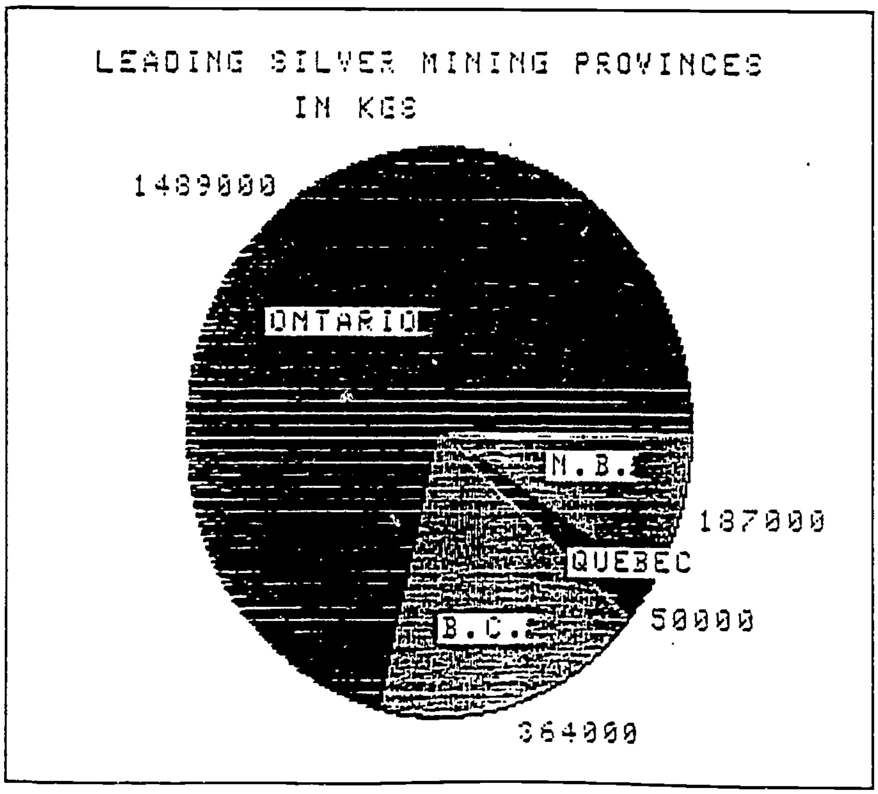


Figure 2.13: Leading Silver Mining Provinces



2.2.5 EMERGENT RESULTS

2.2.5.1 Productivity Tool

Interim Reports #3 and *#4* (Rutledge, 1990a; 1990b) provide evidence that first-time student users find the spreadsheet program to be a productivity tool that shortens the time required to complete certain assigned tasks, empanicpating (MacDonald, et a: , 1977) students from inauthentic learning. Data collected during this reporting period duplicate this finding, as can be seen in the previous quotation regarding electronics students.

2.2.5.2 Teacher Training

The essential issue which must examined, is that of teacher training. While all teachers involved in the project received training in *Democalc*, several had not made the connection of how to use it in their classes. Moreover, if they did use it, it was frequently used as a graphing program rather than as a data analysis tool or a tool for running simulations. Some teachers, such as the ones referred to here, simply forgot some of the information they received in earlier training and requested "refresher" training sessions, now that they better understood the relevance of spreadsheets:

Carl:	I would like another, another session at, at something, spreadsheets because I'm now seeing the real advantages of spreadsheets.
Interviewer:	So another training session on *Microsoft Works* or something, *Democalc*?
Carl:	Yeah and a database.
Interviewer:	Would you like John Rutledge to come out and do a session on spreadsheets or would you like a formal thing set up...for all the teachers?
Carl:	Yeah, I think that would be a great thing.

And, from an observer's fieldnote, regarding Walter's thoughts of spreadsheets:

> He said that he plans to incorporate spreadsheet applications into the course next term as well, as he sees great potential there. He isn't sure if he will use *Democalc* or *Microsoft Works* yet, as he doesn't even remember how to use either of them at this time, and is, as he says, "in desperate need of a refresher course there".

2.2.5.3 Computer Literacy

One pervasive theme, that we have heard from both teachers and students since the beginning of the project, is the importance of computer literacy for everyone. Many of the teachers on this project are now at the point where they realize that computer literacy must include knowledge of spreadsheets. As can be seen in the following quotations, knowledge of word processing packages and spreadsheets are the most highly valued by our teachers:

Interviewer:	So do you definitely feel that all students should have some computer expertise?
Carl:	Yes.
Interviewer:	And to what extent?
Carl:	I think a basic familiarity with, what I regard as being the *lingua franca* of the computer world. I would say something like *Lotus* and *WordPerfect*, are the two that are the two programs that I can think that

would have almost universal application, and I think that everybody should be exposed to them.

Interviewer: So would you be replacing that or in addition to that 25% [of your class time that is presently used to teach math]?

Carl: And I mean that within a drafting subject area students write essays and I don't like essays that are handed in full of grammatical errors so, I mean I do take some time, for example, doing things like resumé writing, and letters of application and things like this. And so writing is...is part of the course. Remedial math, in a lot of cases, is part of the course. And so to...to include something that increases a person's familiarity with, you know, to make choices, with spreadsheets or to be able to produce a document that looks polished, I don't regard that as an intrusion, just simply a part of the course.

2.2.6 CONCLUSION

A set of tools in any trade may be used by a beginner, an apprentice, or a craftsman. Similarly, the spreadsheet tool has a classroom functionality that very much depends on the skill of the teacher. Through discussion, self-discovery, and the demonstration of examples in their particular subject areas, several teachers in the project became aware that the spreadsheet tool might help them achieve the higher-level learning objectives of synthesis and evaluation, and have indicated desires to strive towards this. Some classroom implementation of such activities occurred in the last term of the project. It remains to be seen if such activity will continue. An indication of the degree of implementation in one area is given by the following:

Ken: When I started I saw it as, as a device that students could, we could sit them down around the room and talk to them all at once about the particular problems, and get them involved to some degree, but I was thinking strictly of interactive types of things at the time. And the *Democalc* thing has just given us so many ideas that students can work on.

Interviewer: So it was successful in that area?

Ken: Yeah, it certainly broadened my horizon an awful lot about uses of computers, and we're doing it to the point now where in our area, we can hardly get on the computers, the students are using them all the time.

Regarding spreadsheet functionality, several teachers in the last term of the project expressed a desire to move from *Democalc* to a more comprehensive spreadsheet program such as *Lotus* or the spreadsheet in *Microsoft Works*. Interviews indicate that the main reason for this is to achieve integration with other utilities such as a data base and word processor and to utilize a larger spreadsheet grid.

Therefore, at the end of the project, there are teachers across the entire spectrum from nonuse to integration and renewal. Some have mastered many spreadsheet uses both personally and with their students and others are still trying to figure out how *Democalc* works. The experience gained in the project suggests the following recommendations.

2.2.7 RECOMMENDATIONS

A) Teacher Training

When teachers are trained to use tool software, the examples used should be specific to their subject area and the instructor should be trained in their subject area. The training should go further than teachers will be expected to go in the classroom with their students since this provides the teacher with an overview that is necessary for them to introduce the software effectively and convincingly.

B) Curriculum Development

Teachers, even after initial training using the spreadsheet tool software, often fail to see curriculum-based opportunities where the tool could be effectively used. Therefore, board-level curriculum documents should include, wherever possible, references to computer tool software and examples of its use.

C) Hardware Allocation

At the secondary level, the cross-curricular application of computers requires the availability of computers in several areas. These are:

i) A central lab or pod area which has at least one computer for every two students in the class. Here students can participate in special demonstrations, and occasional software and hardware instructional periods.

ii) The classroom should contain at least three workstations networked to the main lab.

iii) The teacher work area should contain at least one workstation networked to the main lab to provide the opportunity for teachers to prepare work, experiment with software and mark computer-based assignments.

D) Software Acquisition

The cross-curricular application of electronic spreadsheets ultimately requires advanced, professional software which is capable of creating detailed labelled graphs and which can produce both graphs and data output files that can be ported into a word processor.

Entry level software, while being useful at the early stages of training and introduction to students soon restricts the types of assignments and projects which can be assigned.

2.2.8 **REFERENCES**

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