UNIVERSITY OF ALBERTA

Use of Computers in the High School Social Studies Classroom

BY

Lawrence Chapman ©

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

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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research for acceptance, a thesis entitled Use of Computers in the High School Social Studies Classroom here submitted by Lawrence Chapman in partial fulfillment of the requirements for the degree of Master of Education.

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Abstract

This study begins with a case study in which computers were used to teach a section about economic geography in the Alberta curriculum for Social Studies 20 to 16 and 17 year olds, using computers. The major section of the case study involved the students analyzing demographic and economic statistics. It was followed by a section in which the same students used a computer simulation of a developing country. Some very limited statistical study of the project was done. It was found that the students, even those with no previous background with either statistics or computers, reacted very positively and learned well. The students liked the "hands on" experience, and internalized some fairly sophisticated concepts successfully.

The author then proceeded to explore writings of Karl Popper in the philosophy of science, Naom Chomsky in linguistics, Piaget in learning theory, and Habermas in critical social theory. He found links among these writers' theories, and further that these links also related to the learning that had been going on in his grade 11 social studies classroom.

Essentially, three levels of thought and learning were identified in all of the above cases, ranging from low level, basic and highly personal almost intuitive responses through a kind of "intersubjective" world view, and finally, much more abstract and philosophical self-actualization. The role of computers emerged as a kind of linguistic tool which aided thought and permitted the students to internalize ideas with relative ease and move on to higher level concepts and abstraction in the social studies context. The ideas of the linguists, learning theorists, and sociologists provided the link between learning theory and the processes being observed in the practical context of the high school classroom.

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To anyone contemplating post-graduate studies, I can only wish the good fortune to encounter at least a few people of the calibre of those with whom I have had the good fortune to work.

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Chapter 1. The Problem

Introduction

People disagree on what should or can be the role of the computer in the classroom. I have had experience using computers in the social studies classroom, and have also pursued theories of both economic/social change and of knowledge and learning. I have become convinced that the question of the role of computers as an educational tool is one that can be addressed on both the theoretical and the practical level. What follows is my attempt to do so. Rather than concentrate on a statistcial analysis of a particular situation, or to take an entirely theoretical approach, this study will describe experiences with computers in the classroom and attempt to relate these experiences to learning theory. This discussion of the relationship of computers to learning theory will appear in Chapter 5: "Some Observations on Learning Theory and Computers".

The emphasis in the first, and key, part of the study--the case study--though, is on how students interact with computers in social studies related analysis of statistics. To begin with, however, the scene is set by an overview of the nature of human interaction with technology.

Background--Technological and Economic Change

The focus of this study is on the impact of computer technology on education, particularly on the teaching of the social sciences at the secondary school level. I have defined technology as the practical application of knowledge and science to our interaction with our environment. A basic premise of the study is that as we humans face new technologies, in this case computers, we are slow to use these innovations to their full advantage. First, we try to get the new technology simply to improve what the old technologies did. Only later do we gain the perspective appropriate to the technological innovation itself. The use of social studies and computers to illustrate the dichotomy of humans and technology is appropriate on two grounds:

1. social studies is a study of people, and
2. teachers of high school social studies have often been slow and somewhat unimaginative in applying compters to classroom use.[1]

To fully appreciate the relationship between people, technology, and innovation, it is useful to sketch briefly a history of humanity's partnership with technology. To say that we live in an age of technology is somewhat

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[1]Some encouraging results have been obtained in studies at the elementary level though. See specifically the work of Dr. Joseph Kirman at the University of Alberta and the masters theses of two of his students, Lee Armstrong (1980), and Brian Burke (1983), both at the University ofAlberta. Both theses dealt with computer assisted instruction related to data obtained from the Landsat satellite.

misleading. This statement implies that this is, in some way, a new era--that the present age is different from those past because of the impact of technology. This is both true and untrue. The history of civilization is also a history of technology. Technology is one manifestation of that which sets us apart from other animals. In fact, humans have taken technology to a level at which our control over nature is the very essence of our being. Yet we continue to appear to be as much controlled by technology as controllers of it. Consider a brief overview of the relationship between humans and technology.

We invented agriculture to manage our food supply. We extended mechanization beyond agriculture when we invented machinery first to run our farms then to produce manufactured goods. A major break came when we learned to harness the energy of nature, beyond that which our own muscles and the muscles of other animals provided to produce food and material wealth for us. Out of this came the industrial revolution and with it an entirely new level of civilization.

So profound has been that change--the harnessing of mechanical energy--that we have focussed for a few hundred years on adapting it to us and us to it. Yet in the very quest to adapt and expand technology, people are sorely tempted to turn a blind eye to the ramifications of the very phenomenon which has rendered humanity's technological revolutions manifestly unique and creative. This phenomenon is our power of abstract thought and communication. The irony is that this combination of technology, creativity, and abstract communication has propelled civilization to a level where we seem inexorably drawn to make a leap more profound than we have ever done in the previous thousands of years of of civilization: a gargantuan information revolution.

This is not to say that we have not experienced information revolutions before. We have. Spoken language was one revolution; writing was another. Each of these mental tools facilitated major advances in cultural creation and extension; each permitted the transmission of culture and knowledge across time and extended culture and knowledge based on the foundations laid by preceding generations. What renders the present situation unique is that the technology created in the name of ordered knowledge threatens to innundate us in an avalanche of data and an entropy of information: the information is available, but it is so vast that much of it has not yet been organized into meaning, into knowledge. At the same time though, our technology and knowledge also provide the means of harnessing and giving direction to the explosion they have created. Electronic information management in general and computers in particular hold the promise for the order and control we need and seek. Our challenge is to recognize this possibility and exploit it. Education is the key to the challenge.

The intent of this study is to explore the problem of information handling and propose a perspective which will help educators to prepare learners to master this information "monster" which our minds have created. Though the focus of the present study is secondary social studies, the intent is not to limit its implications to social studies only. Although specific reference to case studies will be in the social studies context, more broadly based reference will also be made to learning theory in general and to the place of such theory in a high technology information society.

Overall Limitations and Delimitations

I will describe a situation in which computers have been used in the social studies classroom, first to analyze statistics about economic geography and Third World development and then to describe briefly a related computer simulation. At the same time, I will explore epistemology and linguistic theory as seen particularly by Piaget, Papert, and Chomsky. Underlying questions include the following: can computers and the electronic media extend communication skills and our knowledge significantly? How might the use of computers by students to assemble, manipulate, and assess information change our approach to education? Finally, what might be the ramifications of such a paradigm shift for education as transmitter of culture and facilitator of creativity in Western culture? (Limitations and delimitations of the specific classroom studie will be given in chapter 2, which describes the study itself.)

A. Paradigms of Learning

In my search for some explanation of how thinking and learning are affected by the information explosion we face in 20th century society, I have found several trails that lead to what seem to be dead ends, but not quite. The question is, can one identify a paradigm of learning which transcends previous contexts and, in its transcendence, provides insights which may aid the metamorphosis of information into human knowledge? The choice of the word paradigm is a conscious and directive one: I seek not to be so presumptuous as to advance a new epistemology, nor even to challenge the old one(s). Rather I want to find a perspective compatible with existing theory and knowledge and which, at the same time, promotes creative conjecture in assimilating and harnessing technology. Our quest to tame technology, implicit through the ages, might now become explicit.

It is not coincidental that I choose the word paradigm rather than theory. In the context of the new paradigm people may develop theories. That is another story, and should such development transpire, it will justify the paradigm. In my search, I have explored three routes: 1. psychology and linguistics, 2. the sociology of communicating abstract concepts, and 3. the technology of information manipulation. Each of these areas is in its own right a subject of legitimate and extended study. My purpose in this study is to, in some small way, tie them together into a logical whole in which the social sciences and the computer work together to provide learners/students with an opportunity to internalize basic principles and relationships of the social sciences. At the same time, released from the drudgery of basic searching and organizational tasks, the student may be inspired to creative thinking where previously he or she may have given up discouraged.

In my synthesis of the reading I have done on the relevent technology and on learning theory and linguistics, it became apparent to me that one thing that is lacking is a bridge between the practical application of computers in education on the one hand and sociology and learning theory on the other. To me, the connection was there, but I had not been able to find it being put into words. In attempting to make that connection explicit, my study became more descriptive than starkly analytical. I make no apologies. As the study progresses, I hope thee will emerge a viable description of a link between theory and practice.

It may appear surprising to propose such a juxtaposition, in light of three arguments which appear to auger against successful use of computers in a creative, social studies context:

1. Computers were designed to work with the exactitudes of pure and applied science, and their extension into the social sciences has been slow and limited.
2. Creativity and computers are not obviously related--computers just do what they are told to do.
3. Attempts to relate computers to knowledge acquisition by students at the secondary school level so far appear limited and unimaginative.

Yet I believe this study will show that both theory and practice illustrate that these three arguments demonstrate not the weakness of the above juxtiposition, but the lack of imagination with which educators have used computers in the classroom in the past.

B. Theories of Knowledge in the Context of this Study

Theories of knowledge in Western society have gone through a series of paradigms, ranging from Plato's concept of forms or ideas, to the medieval, religion specific mode of revelation and symbolism, to the logic and ideology bound historical materialism which has given direction to both Marxism and capitalism in industrial society. In the past, scholars and laymen appear to have focused on information itself rather than the context in which it is stored, transmitted, and manipulated.

Late 20th century electronic information handling in general and computers in particular have added an important new dimension to the handling of knowledge. Now the very process of information handling becomes a key tool in the search for extended knowledge. It is a short but important step from Chomsky's grammar to computer directed manipulation of words, mathematics, pictures, and sound. A new level of interactivity between people, including non-experts, and information has been achieved.

To explore the history of theories of knowledge would be more ambitious than this study permits. More modestly, this study seeks to explore a process of learning rather than a theory of learning. The process has been brought about by the advent of computer technology, which goes well beyond the impact of printed word. The printed word, in itself, propelled human inquiry in new directions. Appreciation of the full impact of the printed word was slow to emerge, though the extension of knowledge was rapid and dramatic, as witnessed by the Renaissance and the subsequent scientific revolution.

We have learned much from previous information revolutions. The advent of the printed word, and with it the spread of literacy, for example, contributed significantly to the sharing of information by large numbers of people. This sharing of information and knowledge played a major role in the scientific, cultural, religious, and political revolutions out of which modern society has emerged.

In the case of the electronic information revolution, our recognition of its impact can be instructive now rather than just descriptive at a later date. The electronic information revolution was slow to take off, first with the telegraph, then the telephone facilitating the transmission of language rapidly over long distances. Later, radio and television were logical extensions of this revolution. But, perhaps, the most dramatic impact comes with the advent of computer. A marriage of various technologies relating to electronic information handling has been consecrated by the computer. With this marriage emerges a powerful and expanded means of exploring information and extending knowledge. Though the most dramatic and easily recognized impacts are evident in science and technology, one need look only as far as the classroom to see the impact at a very basic level. It is here that many of the skills and attitudes which the emerging generation will apply in coping with a rapidly expanding information base are being moulded . This generation faces the challenge to selectively organize and internalize that information into knowledge.

Ironically, as we seek to uncover and identify the nature of knowledge, we are constrained by conflicting paradigms. On the one hand appear the biological-scientific paradigms of such diverse people as Piaget, Chomsky, and even Skinner. On the other hand, we are constrained by the philosophical and even ideological pursuits of Habermas and Popper in the realms of sociology and learning theory. Papert seems to provide a bridge between these diverse approaches in his study of the interaction of children with computers. But perhaps a whole new paradigm is warranted. It might seek to relate thought and communication processes not only to spoken and written language, but also to storage, retreival, and manipulation of mathematical, written, pictoral, and aural information by electronic means.

Synthesis of Theory and Practice

The intent of my study has become significantly expanded to include not only a case study of computers in the classroom, but also to touch briefly on the relationship of computers to learning theory. A major focus remains on the case study, but there is interspersed with it some comment on the ideas of the people mentioned above. My interest in and reading on learning theory and linguistics in search of relationships to practice has been extensive, and as I reviewed the case study and references in it to such theory, it became apparent that further explanation would be expected. I have therefore included chapter 4, which seeks to describe the theory and explain its relationship to practice. This renders the work more a descriptive essay than a rigorous statistical analysis.

The first part of the case study involved students analyzing demographic data on computers. My aim was to provide the opportunity for students to transcend statistical analysis in the social sciences. By concentrating instead on the social studies concepts being tested, I believed the students would gain insight into sophisticated concepts related to economic and cultural development. My goal was to be accomplished in two ways. First the students would use computers to analyze statistics in doing a report. Second, they would participate in a computer simulation to explore the ramifications of attempts of a Third World country to develop economically. The simulation would permit students to apply generalizations garnered from the statistical study to a more directly people-oriented scenario.

I began this study with the belief that students were being held back by a kind of "informational entropy". That is, they were encountering so much information that they were having difficulty making the relationhips that would transform the information into knowledge. The technology of electronic information handling could provide an opportunity to harness informational entropy and permit high school students to internalize abstruse relationships which had evaded them when they were faced with only the printed word. I had hoped to motivate students to explore critically some obscure statistical relationships among multitudinous socio-economic data and evidence.

Out of this study emerged recognition of a cognitive process not anticipted. As the case study proceeded, the nature and role of language in the learning process gained an added dimension. The computer-based manipulation of numbers and graphs by students permitted them to formulate and communicate ideas that would have eluded them given more conventional methods of dealing with these ideas. Motivation was a key factor, as students welcomed the challenge of computer based interaction. And the impact on learning of that interaction could be explained in terms of Chomsky's ideal speaker and Habermas' notions of *verstehen,* translated roughly as "understanding". Though the present study concentrates on practical interpretation of classroom based case studies, it must at least acknowledge the relevance of Chomsky and Habermas.

Chapter 2. Case Study--Background and Limitations

Introduction

Grade 11 social studies students were observed interacting with computers in two contexts--first using statistics and graphs and later participating in a computer simulation. Their statistical study will be dealt with first, then the computer simulation. At the outset, though, definitions of terms used in the study are provided. These terms appear in itallics when used later on, to facilitate easier reference to definitions.

Definition of Terms

database: (in this context) a computer file containing small pieces of information such as statistics and names of countries. The computer can sort this information, extract particular information, and draw graphs based on it. (see also spreadsheet)

dot matrix: a printer for computers which prints text and graphics using a series of small dots. The printers used by students in this study (Imagewriters) are quite fast, and give quite good quality printouts)

EXCEL: the brand name of a versatile program for Macintosh computers which sets up and manages databases as spreadsheets and graphs.

humanities: academic disciplines and courses dealing specifically with people, such as the social sciences, social studies and English.

Laserwriter: a printer associated with the Macintosh computer. Based on photocopy technology, this printer, although somewhat slow, produces an extremely sharp, high quality image.

microcomputer: a desktop computer; a small, though often powerful computer. e.g. Apple II series, Macintosh, IBM P.C.

local area network: a means of allowing computers within a limited area, as for example, a classroom, to communicate with each other, usually involving a large central memory storage device and a file server to direct traffic.

physical sciences: those branches of knowledge requiring systematic study and method of substances, natural laws, and animal and vegetable life. e.g. physics, biology, chemistry

programmed learning: highly structured learning using 'learning machines' programmed with set patterns of responses, and branching to other sections fo the learning package based on the student's response to earlier questions. Often criticized as being too rigid and inflexible, this technique is sometimes associated with computers, though it is an insult to the versatility of the computer using sophisticated software (programs).

spreadsheet: a form of software or computer program based on a number of cells (each of which can contain data) arranged in rows and columns. Cells may be interactive, incorporate mathematical formulae, and allow information in particular (user specified) cells to be manipulated, sorted, and extracted in a variety of ways. A common form of handling databases.

spooler: a device used with a computer network, which allows users to stack information for processing (e.g. often for printing out or transmission to another computer) in an orderly manner. This frees up the computer for other tasks while the data are waiting to be processed.

user friendly: a term used to describe computers and software which, though they may be complex and powerful, are easy to use, often even by people who know next to nothing about computers. Often the computer achieves this by "handholding" the user through various steps in a task. The fame and success of the Macintosh is largely based on this quality.

Rationale

It is not uncommon for some students to do well in the *humanities* but poorly in the *physical sciences* and mathematics, or vice versa. This difference is not surprising. These two categories of study frequently involve different kinds of thought. The physical sciences usually demand precise, concrete, rigorous logic. Open-ended, intuitive, creative thought, though sometimes appropriate in the physical sciences, is more often found in the humanities, which focus on people, whose actions are not always precise and clearly logical. The dichotomy alluded to here is confirmed by the eminent mid-twentieth century British physicist, Sir George Thomson in The Foreseeable Future (1955). In this work, Thompson predicted with remarkable accuracy advances in the physical sciences, but was much less successful in dealing with social trends. He explained the anomaly in his predictions by alluding to our failure thus far to identify basic principles governing human behavior.

The purpose of this study, however, is not to prove or disprove the above proposition, but rather to address the question of whether an approach can be identified which will help social studies students integrate both types of thought where appropriate. Can the computer, regardless of the student's particular forte, help circumvent possible mathematics-related barriers in the students' minds? Removing these barriers might promote coping effectively and even creatively with statistical data relating to social studies.

There are times in social studies when students are confronted with statistics relating to such things as population characteristics or economic factors. Their task is to analyze and interpret these statistics. Such is the case in the "Interdependence in the Global Environment" section of the Grade 11 Social Studies course in Alberta. The problem is to find ways to help students integrate these data and related ideas into the social studies context without getting discouraged and confused.

If this integration can be achieved, then the students might not only master the material but also be able to present some original insights, unencumbered by barriers relating to skills and attitudes concerning statistics. If the students' achievement is hampered by lack of ability in mathematics or a negative attitude toward mathematics and statistics, one solution might be to translate the data into a more meaningful form in terms of human behavior and intuition.

Enter the *microcomputer.* A microcomputer can be made to translate the data into graphs so that students have a new, visual format with which to work, thus releasing them from the task of direct mathematical manipulation of the data. The student could concentrate on interpretation of the data and extracting or extrapolating relationships. Yet the solution is not so simple. The very students who have trouble with mathematics are likely also to be unfamiliar with computers and/or have negative attitudes to them.

The pedagogical challenge is to create an environment in which students feel at home with the computer and, without pushing them to become skilled programmers or computer operators, help them use computers to manipulate data and draw graphs. Such a role for computers is a far cry from the *"programmed learning"* syndrome which pervaded the popular imagination prior to the use of computers as an aid in education. My goal was to use the computer to release students from the perceived drudgery of performing a mathematical task in social studies and to free students instead to identify, formulate, and explore critically and creatively social studies related concepts and generalizations, relegating the statistics to their proper function of testing these concepts and generalizations. This would be done primarily by having the students test hypotheses using statistical analysis, then in a different exercise, having the same students navigate a somewhat labyrinthine computer simulation relating to economic development in a Third World country.

Thesis

The intent of my study is to test the effectiveness of using computers in teaching concepts relating to demography and economic growth as part of the grade 11 social studies course. Such computer use involves a number of questions.

1. Can students, many of whom are not familiar with computers and indeed who may demonstrate "computer-phobia," come to feel at home with computers and use them effectively in analyzing social studies concepts?

2. Would preparing students for this computer assisted instruction (i.e. teaching them how to use an appropriate computer database) use up too much social studies class time?

3. Can a balance be struck between *user friendliness* and sophistication in software (computer programs) which will facilitate achieving these ends?

4. Would computer use in this context contribute significantly to the students' mastery of the concepts relating to demography and economic growth as presented in Social Studies 20?

5. Would students subjected to this approach demonstrate a significant degree of critical and creative thinking in interpreting and analyzing data relating to demographics and economic growth?

6. Almost as a sidelight, but a very important one, would this exercise help students appreciate the crucial strengths, weaknesses, and ethics of using computers as purveyors and manipulators of information as the civilization in which they live becomes more deeply entrenched in the electronic information era?

The judgments inherent in these questions generally relate more realistically to a hermeneutic or phenomenological study than to an experimental form of statistical analysis. On the surface, this relationship may not be clearly evident in the cases of questions 4 and 5. However, to concentrate on a statistical analysis of these two issues would shift the focus away from the affective domain, which is a major area of concern particularly in social studies. The affective domain is certainly the major focus of the other questions. Often, in the process of evaluating the role and effectiveness of the computer, quantitative measurement is attempted, particularly in comparison to other alternatives--in this case traditional teaching methods. My contention is that such an approach is too restrictive. It unnecessarily constrains the focus of the study to criteria which, being dictated by existing processes and goals, discourage consideration of new and emerging relationships and phenomena.

Delimitations

In the interests of practicality and the limits of time and resources, the context of the classroom study described here is delimited to a maximum of four

Social Studies 20 classes within one particular school, where students are not consciously streamed. Some students were already computer literate, and some were not. In this sense, the sample was completely random--standard Social Studies 20 classes were chosen, and students were not informed ahead of time that computers were to be used.

The computers used for the statistical analysis were Macintoshes. Each student had access to his or her own computer. Students were able to get printouts by *spooling* data to two *dot matrix* printers and a photocopy quality printer (Laserwriter). The computer lab contained a *local area network* allowing each student to *download* a teacher prepared spreadsheet of statistics.

The software employed was EXCEL, a database, spreadsheet, and graphics package. As well, I, the teacher produced two computer based tutorial packages. One explained basic features and capabilities of graphs in dealing with demographics and economic growth. The other explained how to use the EXCEL program. Copies of these tutorials were made available for every two students. Thus some of the work had to be done in pairs, though each student did his/her own basic assignment.

Limitations

Anecdotal evidence and surveys relating to student attitudes and creative thinking were employed. More about this appears under "Methodology".

No attempt was made to involve computers other than the Macintosh or other software for the students' statistical analysis though this could be done later. This latter limitation could be significant, because many schools use IBM computers and software other than EXCEL. However, the use of the Macintosh and EXCEL were deemed appropriate due to the wide acceptance of the Macintosh in education and the fact that it is very user friendly. As well, EXCEL is an appropriately versatile, yet relatively easy to use piece of software developed for the Macintosh.

Significance of the Study

Aspects of the significance of this study have already been mentioned, but merit further emphasis. Others have yet to be introduced. The study has a specific and utilitarian context. It tests a technique intended to improve the effectiveness of teaching a key part of Social Studies 20. But the technique and findings should also be of a general enough nature to apply to the broader realm of statistical analysis in social studies. Transfer of understanding was also facilitated by the second part of the study, in which the students did the computer simulation mentioned earlier.

Proposals for the use of computers in academic subjects in the past have tended to focus on forcing the computer into variations on existing non-computer techniques such as computer simulations and drill and practice. Results have often been awkward and stilted, neither reflecting significant pedagogical progress nor taking advantage of the real strengths of the computer in information handling. This study is intended to do both: to explore the use of the computer as a pedagogical instrument and to test student use of computers in information handling, i.e. the manipulation of statistics. It is designed to tackle a serious problem in social studies, namely analysis of statistics by non-mathematically oriented students. It addresses the problem by harnessing a function which computers perform best--sophisticated number crunching. The study itself is geared to go beyond standard statistical analysis of results: enhancement of critical and creative thinking as well as attitudes and value judgments by students relating to computers in the information age are broached.

Review of Related Literature

Literature has been surveyed on research related to the use of microcomputers in the teaching of academic subjects in general and social studies in particular. Research indicates considerable interest in the role of computers in teaching academic subjects, though much research has yet to be done. There is also evidence of varied insights and potential for pursuit in several directions.

Two key avenues of investigation involve (1) attempts to harness the tight logic of the computer program and (2) the open-ended, creative imperative of instilling a humanist and creative approach to self actualization and social reconstructive orientation in students' exposure to the vaguely defined "social studies" and "social sciences." These two goals seem to be in conflict. An effective compromise is sought which will meld the two.

Prior to and during the study, I read widely in the area of computer applications in a variety of subject areas. While not all of the articles, books, and ideas I read are reviewed specifically, the whole of the reading experience enhanced my understanding of how computers impact on humans. The primary focus of my literature search was on the use of computers in the teaching of social sciences. It began with a general overview of reasons for and barriers to acceptance of computer-based learning in public schools. In my reading, I found little evidence relating to acceptance of computers by schools as such. However, many articles dealt with the responses of teachers and students to computers in the classroom. The issue of availability of appropriate courseware is also addressed.

My investigation, using the ERIC[1] database as a beginning source, revealed numerous journal articles and books relating to computer assisted instruction in academic subjects. Some thirty four articles are reviewed here. Twelve items of a general nature on computer use in instruction, six on student response to computer assisted instruction or learning (CAI or CAL), four on software or courseware evaluation, and three on social issues are also included. Ten more relate specifically to computers in the social studies classroom. (These numbers total more than thirty four because a few items were counted in more than one category.)

The general papers sought to describe the nature of the microcomputer, its range of uses in education, including administration and record keeping, and some observations on its use in teaching. My personal impression from the reading is that these papers, more than the others, tended to be vague, simplistic, and easily dated. Yet some valuable insights were proffered. Computer simulation was the most frequently cited curricular use of computer software. In particular, two papers referred to the use of computer based tutorials by gifted children. One (Dover, 1983) cited gains in affective thought due to self-paced learning and the experience of positive social exposure of the gifted students to their peers provided by the computer learning environment, though surely the latter could be at least as effectively achieved by other means.

Some papers were inconclusive. For example, in Computer-Based Imaginary Sciences and Research on Concept Acquisition (1985), Allen described a simulation in which students were required to develop a classification system for some imaginary planets based on computer based data about them. Tests using various learning approaches such as matrix or tabular and hierarchical formats were used by the computer with different test groups to determine which would be most effective. Those using tabular formats scored best in achieving the goal of concept recognition.

In "Microcomputers in Education: Elements of a Computer-Based Curriculum" (Donhordt, 1984), three criteria for computer courseware were identified:

1. It must have sound educational objectives.
2. It must reflect awareness of how students will learn from an interaction, and
3. Its objectives and their tests must be measurable.

Impressive though these criteria appear, a major weakness was the failure to define or delimit "sound educational objectives."

In "Interactive Computer Lessons for Introductory Economics-- From Supply and Demand to Women in the Economy," Miller and Gordon (1986)

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[1] Educational Resources Information Center--in this case, the ERIC Clearinghouse for Social Studies/Social Science Education.

observe that

> Philosophers of education from Plato to Dewey to Freire have emphasized the need to involve students in the construction of their own education, and many contemporary educators argue that problem-solving best provides that kind of active environment.

The computer based lessons alluded to in that study were developed in this context.

These two sets of observations best justify the frequent claim that one of the greatest advantages of computer assisted instruction (CAI) is its direct involvement of the student. Self-pacing is the other most frequently mentioned asset. Interestingly, sociology and psychology students who made extensive use of PLATO[1] based CAI (Hartig, 1985) agreed with experts that, to be effective, CAI must be implemented on a voluntary basis, be part of a larger overall program of education, and use interactive and pedagogically sound software. But the students in Hartig's study said computer based lessons should not give the student primary control of pacing. Reasons were not given for the students' comments on control of pacing, which are in direct conflict with the other studies.

Software infusion into the classroom, to Shiffman (1986) involves integration of limited computer applications into overall teaching plans in a manner similar to that in which other audio visual aids have been integrated. Computers will neither be a panacea to problems in education nor a threat to teachers' jobs. Such a view may be significant in reducing resistance to the introduction of computer hardware and software into the classroom, although it falls into a trap common in the early stages of technological innovation: that of trying to force the new technology into patterns of use established for earlier technologies.

Shiffman's cautions concern a kind of worship of technology, which extends logically to specific concerns expressed by Stevenson (1983). Stevenson cautions against equating **training** in the skills of computer operation with **teaching** computer literacy, which he does not define. However, issues such as ethics in information handling, privacy, piracy, and the effects of computers on socialization come to mind in the more broadly based concept of computer literacy.

Stevenson identifies simulations vs. reality, calculation vs. judgment, and the nature of truth as issues relating to computers in education. The latter two points are particularly relevant in the context in which this literature review occurs. Students must be able to distinguish between calculable data, which the computer can manipulate, and their own subjective judgment, which adds

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[1] PLATO here refers to a particular computer based learning program

invaluable elements of instinct, subtle interpretation of meaning and nuances of expression that cannot be packaged to satisfy the requirements of machines. The computer can give output based on calculation. However, judgment concerning the calculation and output is an intrinsically human activity. Similarly, just as people may tend to accept the printed word as inviolate truth, particularly when attributed to proclaimed scientific authority, the student might be tempted to accept computer generated output as being beyond challenge, says Stevenson (1983).

The observations of Shiffman and Stevenson contrast with the wide ranging speculation of Forman (1982) and Becker (1982). Perhaps time is mollifying the heated conjecture of the earlier 1980s.

In Mindstorms (1980), Seymour Papert provides a provocative discussion about how children think and how their thought processes can relate to computers. Children and Microcomputers (1985), edited by Milton Chen and William Paisley, gives a systematic review of utilization of microcomputers in education and studies of their educational effects. Indeed, of all of the items reviewed here, the work of Chen and Paisley is by far the most comprehensive, well organized, and informative.

That there is something generally intrinsic and natural about the relationship of children to computers seems to be confirmed by "Influences on Computer Based Problem Solving: Help Facilities, Intrinsic Orientation, Gender and Home Computing," (Messer et al, 1987). Messer also claims that research shows that outside influences make no difference to children's relationships with computers. Dover (1983) reports that gifted children respond particularly well to computers. Unfortunately Dover says little about the effects of the nature and quality of software used.

Sasscar and Moore (1984) note that various learner control options were utilized by students of algebra and English grammar courses in a community college, but no particular pattern was consistently used by the students. However, Brown (1984), does identify four distinct role models among students using computer assisted instruction:

1. the computer wizard (often not the brightest student in other contexts);

2. the computer hog, who isolates him/herself and his/her achievements from other students;

3. the team player, who pools his/her experiences with other students;

4. the computer catchup, who is perennially behind and in the guise of seeking help from sympathetic classmates, attempts to get them to do his/her work for him or her.

Such evidence provides valuable insight for the innovator of CAI.

Clearly, much depends on the nature and quality of the courseware being used. Some comments on software evaluation are vague to the point of being of little use, particularly when emanating from a limited background in either subject area or computer capabilities (e.g. Rawitsch 1983). Others are detailed and perceptive (Berg 1983). Detailed and excellent guidelines for evaluation are outlined in "Evaluator's Guide for Microcomputer-Based Instructional Packages" by MicroSIFT, developed by Northwest Regional Educational Laboratory of Portland, Oregon.

Although the primary intent of this study is to survey the use of computers in the social studies classroom, their role in social studies curriculum includes another feature which cannot be overlooked, namely value issues related to computer use in society in general and in education in particular. The ERIC book Using Micro-computers in the Social Studies Classroom (1983) comments on the pervasiveness of computers and the need to come to grips with them. Glenn and Klassen (1983) and Hepburn (1983) are worth reading for their stress on social and political issues. Hunter (1983) pleads the case for computer literacy and expanded computer use in social studies.

In the field of social studies, Garson (1985) observes that although there has been significant research and software development in the social sciences, this research and teaching tradition exists almost entirely outside the mainstream of social science journals and textbooks. Paradoxically, the impact of computer simulation has been relatively greater on teaching than on research concerning its effect on teaching. Further, attempts at simulation in research poor environments inevitably lead to models with low reliability, oversimplification, and neglect of causal factors. Garson's work, which contains over ninety related references, concludes that computer simulation remains a step-child to the social sciences. This relationship might help explain the limited impact of computer simulation on the teaching of social studies and the social sciences in schools. Such a finding is complemented by the observation of Douglas (1986) that historians are using computers in a limited way in the classroom--for student projects and tutorials.

Part of the reason for such limited use in the past has undoubtedly been a lack of good courseware. I have reviewed courseware for the Edmonton Public School Board for some three years and have found, with a few major exceptions, that courseware quality has been weak. Yet some quality software does appear to be emerging (Daetz 1985). In "Bellwether Social Studies Programs," Daetz reviews five simulations which he deems to be of high quality. Indeed, his description seems to bear his judgment out, in at least some cases. A notable exception is the program "Revolutions: Past, Present and Future." I have also reviewed and found the program to have some good points but to be so cumbersome and time consuming that it was rejected by teachers and students alike. Yet Rothman (1982), like Daetz, extols the virtues of this simulation in the article, "Using the Microcomputer to Study the Anatomy of a Revolution." Such discrepancies may show the difference between software evaluation by review and software evaluation by actual classroom use.

Daetz also praises an open-ended simulation, "Simpolicon: Simulation of Political and Economic Development," which appears somewhat similar to, though more open ended than, "Decide Your Excellency," which has been used extensively and with notable success by this myself and my colleagues in an Edmonton high school (see "A Computer Simulation" later in this chapter for greater detail). A promising feature of "Simpolicon" is that a local area network version is available. Lack of such a version is the one significant flaw in "Decide Your Excellency." Other programs reviewed by Daetz range from unimaginative drill and practice ("Africa") to peace education oriented "The Other Side."

Abelson (1983) describes successful use of a simulation on the Great Depression in a high school. Again, one of its big selling points with the students seems to have been their direct involvement in the simulation.

Miller and Weil (1987) discuss software developed to teach supply and demand as well as the role of women in the economy. They claim that its tutorial format, with extensive branching for review and remediation, has been enthusiastically accepted by freshmen university students, though it should be noted that one of the authors was also the author of the software in question. If this software is as effective as claimed and their assessment of student response is valid and unbiased, this is welcome news to me. I have often bemoaned the lack of software for high school economics, which seems a natural area for such software.

"Computer and Database Management in the History Curriculum" (Johnson 1987) involves a case study evaluation using ethnographic data collection techniques, and explores the use of computers in a high school to sort, categorize, and classify historical data. Lack of enough computers imposed undesirable time constraints, but students liked the student-centered activities. Johnson observes that user-friendly software is needed to allow people to focus on the task at hand.

Experience with the use of microcomputers in the social studies in England seems to parallel that of North America. Kent (1983) describes computers as popular with geography teachers, though history teachers see them as a gimmick. In economics, much software was promised, but little produced. Another problem was limited teacher awareness. The scarce research available suggests that less able students may have negative attitudes.

Finally, the booklet, <u>Computing in the Social Studies Classroom</u>, put out by MECC in 1984, suggests five ways in which computers can be used in this context:

1. as a method of delivering content;
2. as a tool for retrieving and analyzing information;
3. as a tool for developing thinking skills;
4. as an example of technology use in society; and
5. as a classroom aid.

The booklet also suggests sources of software and includes a discussion of computer materials evaluation similar to that mentioned previously in this paper.

In summary, evidence indicates an acceptance of computers by students, especially when they are not mandatory and when software is truly interactive and paced by the student. Teachers appear slower than students to accept the computer in the classroom. This reluctance may reflect the larger framework in which lay adults appear more skeptical than children about the role of computers in education and society. Acceptance and success of hardware and especially software revolve around ease of use, appropriateness to the overall curriculum or particular aspects of it, and flexibility and student control of pacing.

There appears to be a heavy emphasis on simulations in social studies. Though not mentioned as such in the studies, one might conclude that a major attraction of simulations is that they employ "turnkey" operation and appear user-friendly. That is, simply loading the software sets all of the computer's parameters, and operation requires little or no knowledge of the computer operation itself. The user then is able to focus on the subject area objectives and successfully operate the program. Drill and practice and tutorials are accepted more for remedial work by individual students than for instruction of the class at large. Database management is less frequently used in the social studies classroom. Probably its sophistication brings added complexity, which requires time for mastery and scares off many teachers and students. However, database manipulation promises to promotie critical and creative thinking.

Among the works reviewed, many were descriptive and appeared aimed at familiarizing the neophyte with basic information. Accordingly, they frequently lacked depth. Such items were not sought out by the reviewer, but emerged as dominant in the literature available. Phenomenological and ethnographic studies were common, but lacked depth. There remains much room for quantitative analysis as well as more in-depth qualitative studies.

Some combination of quantitative and qualitative study would reflect the promise of computer use in teaching social studies. Social studies more than many areas of education centers on a balanced mix of critical/analytical and creative thinking. Creative use of the computer in facilitating such a mix of thinking styles, through flexible computer simulations and open-ended database manipulation, appears to hold great promise. Documented research is needed to test this premise.

Chapter 3. The Case Studies--Computers in Social Studies

The Study Design

Statistical Analysis by Students

In the Social Studies 20 course as prescribed by Alberta Education, one half of the course is devoted to what amounts mostly to economic geography, with an emphasis on changes and development in Third World countries. In their textbook, World Prospects, students are presented with a table containing a number of statistics relating to demographic and economic features of a large number of countries. From the table, the authors of the textbook have selected 35 countries representing a cross section of various levels of economic conditions and geographic features (see Appendix 1). The textbook also explains several forms of statistical analysis, including several types of graphs which can be used in this analysis. However this type of activity is frequently given short shrift by both teachers and students due to a mutual antipathy toward such an approach.

It occurred to me that much of this antipathy could be overcome if the students were released from the inherent burden of manipulating the statistics and constructing the graphs. It would be more relevant to their study if they could formulate hypotheses and have computers perform the statistical drudgery. The students then could interpret the graphs, test their hypotheses, and write up their findings. This might be somewhat analogous to learning to use a second language without being forced first to memorize copious and complex grammatical rules. Therein lies the basis of this study.

Four semestered classes of Social Studies 20 were used: two in the first semester and two in the second semester. In the first semester, the assignment was given in early December, and in the second semester it was given in mid April. Prior to the assignment, all classes were given an introduction to demography and economic growth in developing economies. Each class was then given a copy of the assignment (see Appendix 2). Each student was asked to develop a hypothesis relating to some of the statistics shown in the assignment. Students were required to submit their hypotheses to the teacher for approval. Approval would be granted to the student on the basis of the appropriateness of the hypothesis to the social studies curriculum and to the available statistics. It was explained that the statistics would be available on a computer database, and the students would be expected to choose appropriate statistics and build a graph or graphs using a computer.

After choosing a hypothesis, students were introduced to the computer lab and given tutorials in the use of the spreadsheet and graphing program, EXCEL. Because students caught on quickly to this feature, it was necessary to provide them with only two class periods, one hour each, to complete it. In fact, several students completed this part of the study in only one period. Students worked in pairs on the tutorials, but each was expected to do his/her own assignment. Students then spent six classes working on the main assignment. Technical assistance was available from the teacher and a lab aid. Each student had his/her own workstation and was assigned his/her own private space on the hard disc drive attached to the Local Area Network. They could use their own floppy discs for backups if they wished. Each student was able to access EXCEL and the database on the hard disc drive. One copy of each of the tutorials was made available to each pair of students. This was necessitated in part because it was not possibie to mount the tutorials on the hard disc drive.

Assumptions

To the extent possible, this study has been structured to prevent bias from causing significant distortions. Still, some assumptions are necessary and should be recognized, for not all factors could be controlled. Classes should be approximately the same size. In fact class sizes were 20, 22, 26, and 23 students respectively.

Classes were assumed to be heterogeneous. It should be noted however that the semester one classes tended to contain more students who had previously failed this course than did those in semester two. In period 1 of semester 1 there were 10 repeaters and in period 2 of semester 1 there were 7 repeaters, but in semester 2 period 5 and period 7 each had only 2 repeaters. It is recognized that some streaming is effectively done by students to accommodate particular timetables, but, other than the inordinate number of repeaters, streaming appears not to have been a major factor, as indicated by class averages in other parts of the course.

Differences between classes were not as significant as I first thought they might be, because the intent of the study was not to compare classes to each other but to observe reactions to the assignment and assess its general effectiveness in achieving student mastery of concepts and to observe student attitudes to the curriculum and the procedure.

Procedure and Observations

The students generally displayed a positive attitude when introduced to the assignment and appeared anxious to get at the computers. Some expressed reservations based on their lack of experience with computers, but this was quickly mollified by assurances from the teacher and other students that microcomputers in general and especially this particular configuration of Macintoshes and EXCEL would be relatively easy to master. A few of the brighter and weaker students however remained skeptical. In fact two opted to do the assignment without computers even though this option was discouraged.

Skeptics were inclined to say "I don't like computers" or "computers don't like me." These students tried to skip steps and showed intractable impatience when the computer did not immediately respond as they wished. They displayed a deep-rooted mistrust of computers and, through this mistrust and impatience, failure became a self-fulfilling prophecy. The majority of students however responded positively and were encouraged by their results.

After having the assignment explained to them in very broad, general terms, students were shown a printout of the statistical table which they were to use, although they would also later be permitted to enter other appropriate statistics into a computer spreadsheet and work with them if they wished. Next, they were introduced to the computer lab and the first tutorial.

Student reaction to this tutorial was interesting and informative. The tutorial explained the nature of the graphs available on EXCEL and tested their comprehension of such graphs, using social studies based examples. A conscious attempt was made in construction of the tutorial to encourage transfer, but to avoid examples which could be simply lifted and applied by the student without significant modification into the larger assignment. See illustrations 1 and 2.

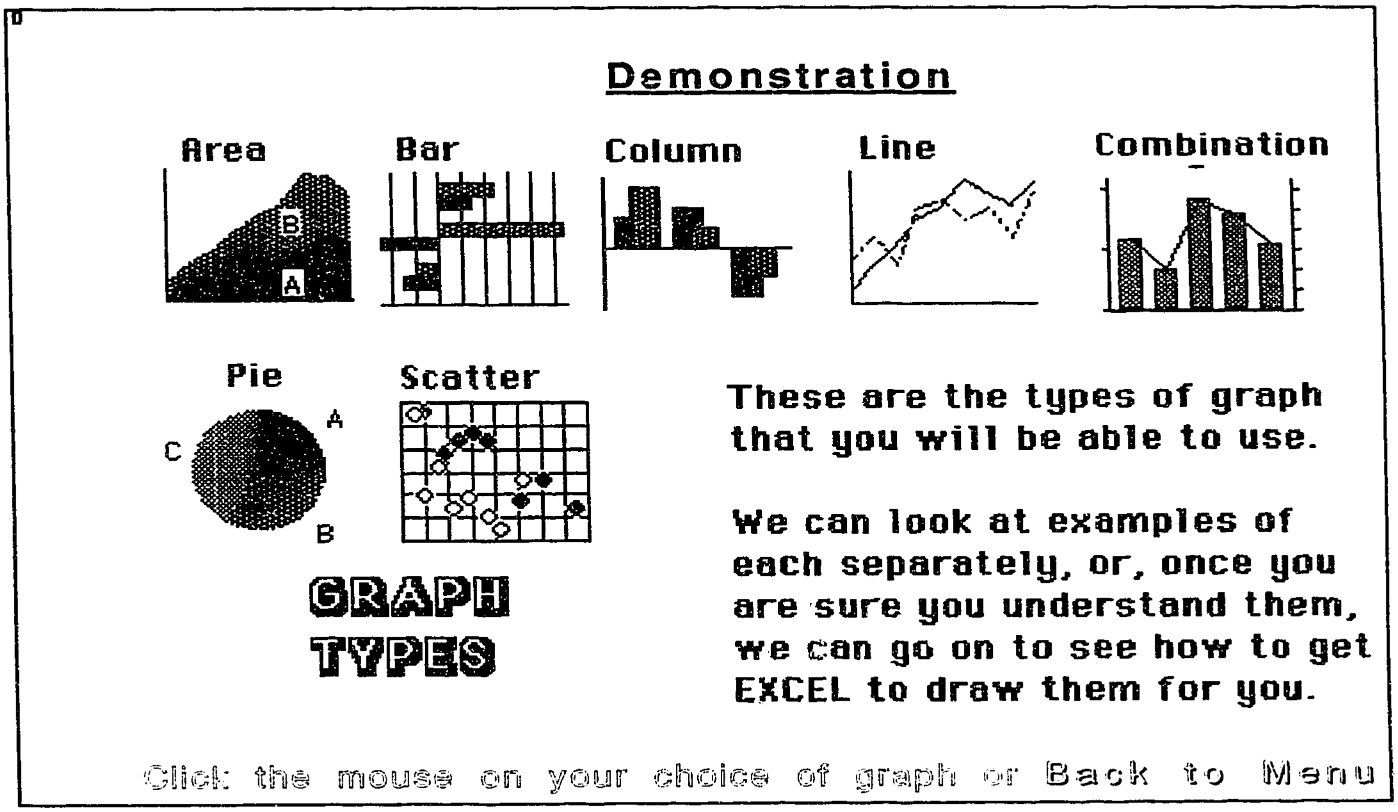


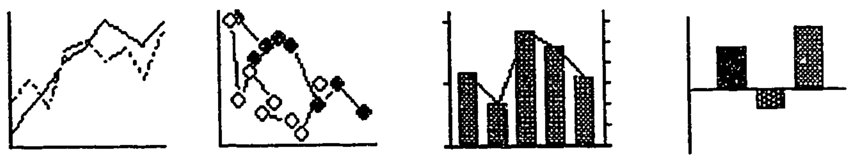
ILLUSTRATION 1. This shows the kinds of graphs available to the student. By placing the computer's cursor on any one of the graph types, the student could get the tutorial to move to a social studies related illustration and explanation of that graph type.

On the following page appear a typical question the student would encounter and the response he/she would get by choosing (clicking the cursor on) the correct answer [scatter]. In this case it is a two part question. The student would not be permitted to go on to the next question until he/she got both parts correct. If he/she chose a wrong answer, the tutorial would explain why it was wrong and permit the student to try again.

File Menu ?

3. You are given the mean daily high <u>temperature last year</u> for 20 different locations. You also know <u>how many boxes</u> oforanges each of these places produced last year. You want to see if there is a relationship between the temperature and orange production.

Line Scatter Combination Column



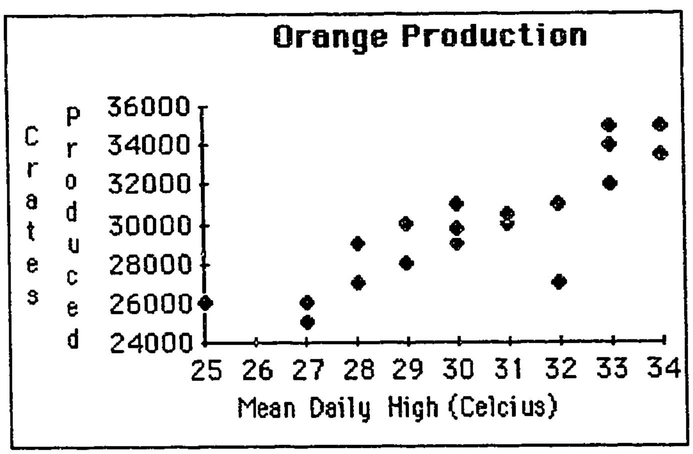
Line Scatter Combination Column

Pick the graph which would be best to use for this test.

File Menu ?

YOU'VE GOT IT!

Now, suppose that we decide to show the number of crates on the vertical (y) axis, and the temperature on the horizontal (x) axis. Here is the result:



The "line of best fit" seems to be sloping upward to the right. What does this tell us?

- that people eat more oranges in hot weather.
- that production generally falls as temperature rises.
- that there seems to be a positive corelation between temperature and production.
- it is rather meaningless since our scales are so different.

(Click on the best answer).

ILLUSTRATION 2: A quiz item from the tutorial. **See page 23 for explanation**

A multiple choice quiz by the computer tested students' comprehension of the material. The computer tracked student response. Where incorrect responses were given, the student was led through further analysis and explanation until he/she gave the correct response to that question. The student was not permitted to move beyond this tutorial until he or she had completed a session with the quiz in which he or she had responded correctly to all questions.

Upon completion of this tutorial, students were asked to formulate hypotheses concerning cause-effect relationships which they would test, first by constructing graphs then by providing a logical explanation based on textbook information, previous classroom study, and/or further reading. Beginning with hypothesis formulation, students ceased to work in pairs. They were warned that although similar hypotheses would be permitted, if more than one student did sufficiently similar graphs and analyses, only one of these assignments would be marked and the mark would be divided by the number of students involved and distributed evenly among them. Not surprisingly, this problem did not occur.

At this point, students were introduced to the tutorial on how to use EXCEL to construct graphs. Each class was also given instruction and demonstrations on key features and complex procedures involved in the use of this spreadsheet and graphing package. They did not make much use of the computer based tutorial though, preferring to rely on in-class instruction and individual assistance from the teacher, the lab technician, and each other. They were also encouraged to use the word processing program, Microsoft Works, to write up their report, but were given only minimal instruction on its use. In its basic operation, which was all that these students needed for their assignment, Microsoft Works is relatively simple and almost self-explanatory. Many students were unenthusiastic about using it, perhaps because 37 of the 91 students had not previously learned keyboarding skills and felt it would be less work for them to write out their reports.

Extra lab time was made available at noon hour and after school, and several students availed themselves of these opportunities. Some preferred to work alone, seeking only minimal assistance from the lab aid. Others were pleased to avail themselves of individual assistance offered at these times by the teacher. The most commonly expressed criticism was that the teacher did not provide enough individual assistance. I did in fact provide the maximum such assistance possible given the physical constraints of the situation, but was limited by the inability to be in two or more places at once. This is a frustration which I have also experienced while teaching computer literacy. Perhaps because the computer lends itself to interaction and individual instruction, the student extends his/her expectations to make the same demands of the teacher as of the computer. As a teacher I find this situation much more stressful than standard teaching methods, but also correspondingly more satisfying when students experience the satisfaction of success, which they usually do provided they exercise appropriate patience in the long run. I was prepared to accept the extra stress, based on my experience in teaching other computer related courses. I found however that other social studies teachers were not so readily inclined, even when confronted with the notably more structured and less demanding task of setting up a computer simulation. (See page 36#).

Partly due to logistical problems, students were allowed only three or four periods (out of six) per week in the computer lab. The rest of the time was spent in the classroom on regular instruction. Students responded well to this mix. Although they used a little bit of the regular class time to ask questions related to the assignment, they welcomed the variety of instructional techniques that this configuration provided. Each class was given six regular 63 minute class periods of lab time for the main assignment (not including the tutorials). Most assignments were turned in on time and were marked in terms of the template shown below.

Social Studies 20 **Analyzing Statistics**

Name:

Hypothesis...			/10
Graphs			
appropriateness.......	/10		
labelling......................	/5		
clarity..........................	/5................	/20	
Report			
explains findings.....	/15		
evidence......................	/20		
clarity..........................	/10		
conclusion..................	/15		
mechanics...................	/10.............	/70	

(Teacher Comments:)

"Explains findings" indicates the part of the mark which related to how well the student explained his or her statistics and graph. "Evidence" refers to how well the student backed up the statistical work with evidence based on readings and logic to illustrate and analyze logically cause-effect relationships purportedly shown by the statistics and graph(s).

Class averages on the assignment were as follows:

Class:	Number of Students:	Average on Assignment:	Course Average:
Period 1, Semester 1:	20	57%	55%
Period 7, Semester 1:	22	62%	60%
Period 5, Semester 2:	26	61%	59%
Period 7, Semester 2:	23	65%	62%

All of these averages were low compared to the course averages of all Social Studies 20 classes (66%), most of which were non-semestered. As has been previously stated, these relatively low averages may be explained in large part by the kind of marks achieved by semestered classes generally. Because many of the other social studies classes did very little work with statistical analysis and graphs, it was not deemed possible to compare the classes in the study group to the general social studies 20 population with specific regard to this section of the course.

Findings and Analysis

Each class averaged two to three per cent better on this assignment than it did on the course as a whole, which may be considered not to be significant. However, factors other than marks may tell a more important story in terms of learning and attitudes in this case.

An example serves to illustrate the point. One key idea studied in the "Interdependence in the Global Environment" unit of the Social Studies 20 course is the theory of the demographic transition. Put in the simplest possible terms, the idea is that as a society moves from a traditional base and a low level of economic development -- often subsistence agriculture -- to more efficient food production and ultimately industrialization and material abundance, birth and death rates decline. The society moves from high birth and death rates to low birth and death rates. At both ends of the transition population growth appears to be relatively low and stable. But because death rates decline earlier and faster than birth rates, the society goes through a period of population explosion. Social studies 20 students study how and why this transition occurs, and its interrelationship with the culture and values of the society in which it is occurring.

It is standard procedure for students to have the theory explained to them and then to read case studies which illustrate it. Included in the explanatory material may be a number of demographic and economic statistics. The classes involved in the computer assisted approach discussed here were expected to extrapolate hypotheses related to the demographic transition or other concepts relating to demography and/or economic development, to test their hypotheses statistically, and to verify their findings--either positive or negative--on the basis of information they could pick up from other research sources.

Students quickly caught on to the idea of hypotheses, although the hypotheses they constructed were often awkwardly worded and lacking in testable logic, as illustrated by the examples below:

1. The higher the literacy rate of a country, the more financially well off that country will be in terms of the gross national product and that country's manufacturing output.

Rather than intervening at this point, I asked the student who constructed this hypothesis to consult the statistics on the computer database provided and proceed with his graphs and explanations. He proceeded to select statistics and construct graphs. Some strange configurations developed, but because the students could easily experiment with different statistics and/or graph types, this student was simply annoyed rather than defeated in his failure. He asked permission to modify his hypothesis. I said the basic intent implied in such hypotheses appeared worthy of pursuit, but agreed that clarification of wording would make it easier. This particular hypothesis was not borne out, even when the student plugged *raw* GNP data in and constructed graphs. (The raw GNP data had to be obtained elsewhere and added to the computer database. But this was easy to do, and he did not mind.)

At this point it occured to the student that GNP varied not so much according to the factors he was comparing as to population size. His hypothesis might be changed so that all variables appeared as rates:

1. Societies with high literacy rates tend to have higher per capita gross national products and higher per capita manufacturing output than do societies with low literacy rates.

However, a problem still remained. Because countries were listed on the database in alphabetical order, they were transferred to the graph in the same order. The only thing evident was that other factors appeared to bear no relationship to a country's name! I showed the student how to sort the data on the computer so that the countries were ordered from lowest to highest per capita GNP. It was amazingly easy and the actual sorting process for the 35 countries and three variables in question took about two seconds. His new graph seemed to make more sense. However, there still seemed to be anomalies. Second World (i.e. "developed" Communist) countries tended to have inordinately high literacy rates compared to their per capita GNP, and some other countries that were resource rich and/or dependent on tourist income appeared to have inordinately high per capita GNP compared to their gross manufacturing output. Yet, in general, the relationship suggested in the hypothesis seemed to hold.

At this point, the student was hooked. He had quickly discovered the flaw in the wording of his hypothesis as his first computer run failed. The second computer run (after the re-ordering of data) provided clear pictorial evidence, in the form of a graph, that he was on to something, but there were still some unexplained inconsistencies. He was making progress quickly and relatively easily, and the computer was presenting his findings in an impressively clear and accurate manner. Now he must explore the available literature to try to find support for the apparent relationship he had developed and to explain the apparent inconsistencies. He approached the challenge enthusiastically.

The basic goals of this exercise with computers could have been pursued by more conventional means such as a standard library based research assignment or a case study. But the student's learning experience in the computer based context was unique in several important ways. Basic information was easy to find on the computer database and to manipulate (as in the sorting sequence). Activity was student generated as illustrated by the sorting of data, clarification of hypothesis, choice of graph type, and construction of graphs. The basic goals of the student remained in the forefront of his mind throughout the exercise, and he was not engulfed in a morass of calculations. Feedback was virtually immediate, and the graphs were clear and relatively easy to interpret, as compared to tables of statistics, for example. The student was an active participant at most points in the exercise, which was important for two reasons. He related to what was being done and, sometimes practically without realizing it, he imposed his reasoning rather than being drawn passively along as one is when absorbing written or even verbal information from someone else.

A second example seems to confirm the first, and add some further insights. This hypothesis was developed by a student:

2. The more proteins people consume increases their life expectancy, which in turn reduces the death rate and population density grows. *(I have chosen not to change the awkward wording at this point. It does not destroy the intrinsic logic.)*

In this case, the necessary data appeared on the original database, so the student did not have to seek outside sources. He proceeded directly to graphs and analysis. He soon established that there did, indeed, seem to be a relationship between protein intake and life expectancy, but then his logic appeared to depart from his statistical findings as illustrated on his graph. There seemed to be little or no relationship between death rate and population density. He proposed that rapid population increase did not necessarily accompany a declining death rate.

To test this, he needed statistics for rate of natural increase, obtained by subtracting the death rate from the birth rate. These figures were not given, and the student was not enthralled by the prospect of calculating this statistic for all 35 countries in the sample. When he discovered that he could get the computer to do the calculation for him rapidly and accurately simply by feeding in a formula for one cell and getting the computer to repeat the calculation for succeeding cells, he gave it a try. He had in fact discovered a variation on the theory of the demographic transition. (As protein intake increases and death rates decline, birth rates also decline, but only after a time lag. Hence the population explosion in developing countries.)

But how could he explain the lack of correlation between population densities and levels of protein intake? This defied analysis on the basis of data available on the computer database. Then inspiration struck. A glance at the statistics showed that Canada and the United Kingdom had high protein intake, although Canada has a low population density and the United Kingdom has a high population density. At the samo time, India has low protein intake and a high population density. Perhaps economic, cultural, and/or geographic features come into play. This would require further research.

In this case, the student had been able to obtain one of the variables he needed (rate of natural increase) by getting the computer to do the calculations for him. Having done this, he found that his graph still illustrated discrepancies in population density which he did not expect. But he would never have ventured this far on his own; or so he claimed. Now he could explore other avenues that were not accessible from the computer database. But that was all right. He had, by computer manipulation of statistics and study of computer constructed graphs, been able to concentrate on his social studies task and reach a point where he would explore new lines of reasoning. Both these examples illustrate a phenomenon experienced by many students. Rather than being intimidated by the statistics, the students exercised power and control, letting the computer do the calculations and construction of graphs for them while they continued to concentrate on their social studies related goals. The graphs, being constructed according to the choice and at the command of the students, were viewed by the students as their own creation, providing a sense of pride and ownership. This attitude became apparent in the comments made by the students discussing their work with each other and with the teacher. The graphs also translated relationships into a pectorial form relatively easy to interpret. Once again, students' comments reflected a level of understanding not evident when they were dealing only with the raw statistics.

An interesting phenomenon surfaced with a later group of classes. They were given virtually the same assignment, except that due to problems booking the computer lab, time did not permit as much advance preparation before the students began their hands on experience with the computers. Nor was there enough time to give them the extended tutorial in how to use the graphics program on the computers. There were more complaints from this group that they weren't sure what was expected of them and that they had trouble making the program work. The inevitable conclusion is that extensive preliminary preparation both in terms of the general assignment and in a tutorial on using the computers and the Excel program are very important to the success of the assignment.

In the statistical analysis assignment, students were required to reason creatively, take a stand, and defend it in their written reports. Some did much better than others, but almost all said they enjoyed it and seemed to internalize the knowledge gained almost without realizing it. But what would be the case in the more structured context of a computer simulation?

"Decide Your Excellency"--A Computer Simulation

After the students in "Interdependence in the Global Environment" finished covering most of the theoretical material relating to economic geography, they were encouraged to do a case study. In lieu of a conventional case study, the computer based simulation, "Decide, Your Excellency", a joint production of ACCESS and TV Ontario, is sometimes used. I used it with the same classes which did the computer based statistical analysis just described.

In this simulation, students deal with a mythical country similar to many of the post-colonial countries in Africa. This country has just experienced a coup d'état which has resulted in the student becoming the president of the country. His or her job is to guide the country through five years of economic development. The country faces economic, ethnic, cultural, and religious conflicts similar to those often found in developing countries.

While piloting this computer simulation for Alberta Education in 1985, I tried many different configurations, ranging from each student having his or her own copy of the simulation and his or her own computer to having the entire class work as one large team. The approach I found most successful was to divide the class into groups of 4 to 6 students. Five seems ideal -- for one thing, an odd number of students eliminates problems of ties if they vote. The simulation is run on Apple II series computers, and progress is tracked on a "Class Management Disc." Students can stop at any point and return later to where they left off, and/or get a printout of economic statistics reflecting their progress so far.

Each group would choose a leader, who would become "President Gutpela" while the rest of the group formed his cabinet. This was the approach I used with the class in question. The students were slightly miffed that this simulation operated on "lowly" Apple IIs--by now they had been spoiled by their experience on the much more sophisticated Macintoshes. However, the simulation is well constructed, and the students' disappointment was neither deep nor long-lived. They got right into the simulation.

They earnestly applied the theory they had learned earlier in the course, and it usually worked. But the simulation is set up so that students are often thrown curves which result from local cultural and religious variables. The addition of the unexpected adds a considerable dimension of realism to the simulation, which the students appreciate. Despite this, most students experienced a coup d'état or assassination on their first run of the simulation. It became a challenge to see which group could successfully complete the five years first. The teams worked well together, and as I casually ambled from computer station to computer station, most students were deeply engrossed in planning sessions and policy debates. They had indeed internalized the concepts from the earlier part of the course, and were anxious to put them to the test. No external motivation was required here!

It usually takes three class periods of 63 minutes each for the majority of the class to successfully complete the simulation. These classes were not exceptions. I followed up with debriefing sessions. The students were enthusiastic about the simulation, and the insights they proffered in the debriefing seemed to demonstrate that learning had pervaded both of their experiences with computers. For example, having worked with statistics extensively in the graphs assignment, the students often commented on the use of statistics in the simulation, comparing such things as the relationship between literacy and income levels in the simulation to those in the statistical table with which they had been working previously. An interesting and important sidelight, though, is that they recognized the simulation for what it was -- a mythical creation subject to the biases and fallibility of its creators. Having themselves had experience manipulating information on computers in the previous assignment, they saw the computer neither as subject to flagrant errors nor as an infallible purveyor of truth and wisdom. When their attempts to introduce birth control in the simulation met with meagre success, they frequently observed that this corresponded to countries in the statistical table that were at similar levels of development to the country in the simulation. But they frequently also lamented that they thought the simulation was constructed in such a way as to make this situation frustratingly difficult to deal with. The computer was their servant, not their master.

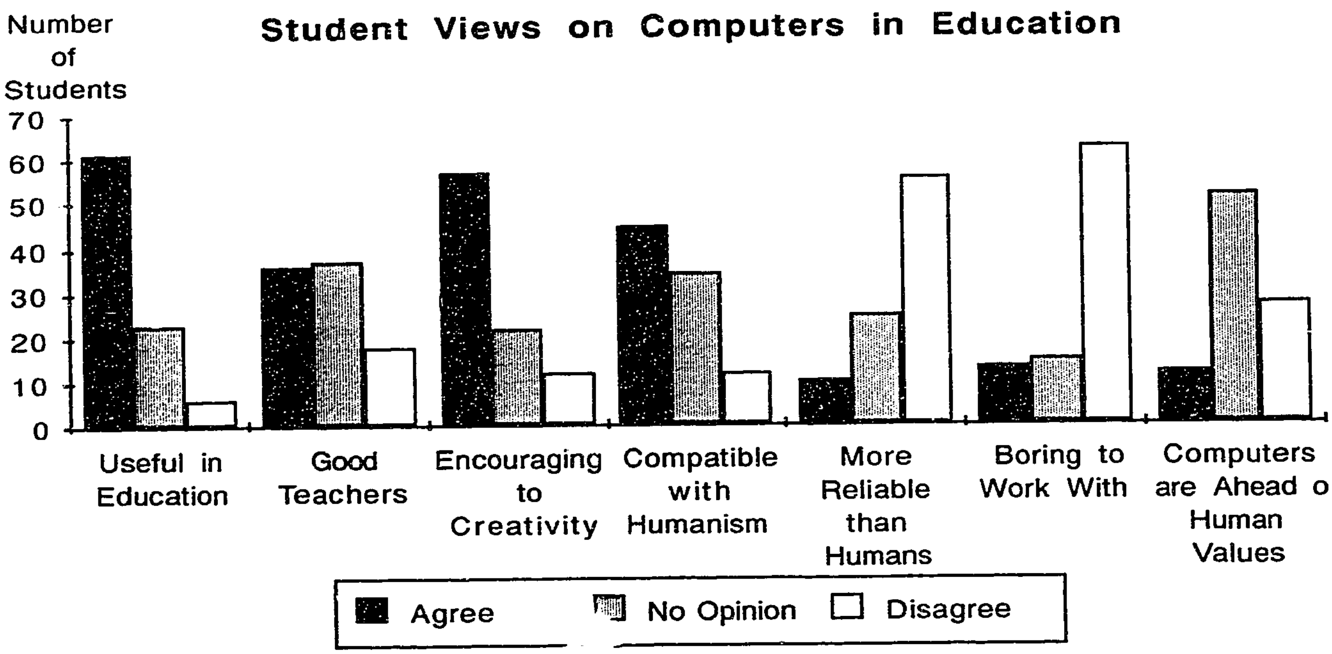
Conclusions

I was concerned not so much with improving student achievement on tests, although this is certainly desirable and within modest limits did occur, as with questions relating to how the use of computers assisted in instruction and how the students related to the computers.

As can be seen in the survey results depicted in illustration 3 on the following page, students' attitudes itoward computers were quite positive to begin with, at least in terms of considering computers useful in education and encouraging of creativity. It must be noted though that a majority of the students considered computers to be less reliable than humans, though they did consider computers interesting to work with.

After their work on both computer assignments was completed, I asked the students to give me a written response about their attitudes to computers and the assignments. The responses were anonymous, so there appears no reason to doubt that their responses represented a genuine expression of their views. Between these responses and my observations of the students while working on the assignments, some interesting observations emerge. The graph at the top of illustration 3 represents data taken from the table below it. The two together should be self-explanatory.

With only two exceptions in a total of 91 students, the students felt sufficiently at home with computers to work well with them, and most enjoyed the work. Students spent seven classes of assigned time in the computer lab, plus whatever extra time they wished at noon hours and after school.



Data are based on 1989 survey of 4 Social Studies 20 Classes (91 students) before they began working on a social studies assignment using computers.

Topic:	Agree	No Opinion	Disagree
Computers are useful in education.*	62	23	6
Computers are good teachers.	36	37	18
Computers encourage creativity.	57	22	12
Computers and humanism are compatible.**		45	34 12
Computer analysis is more reliable than human analysis.***	10	25	56
Computers are boring.	13	15	63
Computer technology, being ahead of human values is misused.	12	52	27
Respondent likes math and statistics.	37	39	15

* Based on responses to the following statements:

1. I think that computers can make education more interesting.
2. I think computes can help me to learn about other subjects.
3. I think computers are over-emphasized in education.

** Based on this statement:

Computers take humanism out of our life. We should guard against them in the humanities like English and social studies.

*** Based on response to this statement:

Computers don't make mistakes. I trust computer analysis more than human analysis, even if the humans are "experts".

(previous page) ILLUSTRATION 3: Survey Results

Most students did not spend much if any of this extra time available in the lab. An exact measure was not available, due to the open-endedness of the extra time available, but my general observation is that about eight to ten students spent an average of one to two hours extra in the lab. Lab time spent was not unreasonable, given the time and facilities available. Time needed to familiarize students with the computers was generally only one class period, surprisingly short. The software used proved very good for the job at hand, and students responded positively and quickly in adapting it to their assignment. The essays which accompanied the graphs indicated that most students grasped the social studies concepts well. This was borne out later in class discussions and their response to the computer simulation. They also viewed data critically, and ultimately displayed creativity in its interpretation. Some did need prompting to go beyond the data to seek explanations from other sources such as their text and other texts. Perhaps most significant, as illustrated both by the survey results shown in illustration 3 and in discussions, students came to realistic conclusions about the reliability of computer manipulated information. They quickly grasped the old computer adage, "garbage in, garbage out!" This was evident as they questioned not the computer programs themselves, but the reliability of the statistics. Thhe students' healthy skepticism came through in both the graphs assignment and in the computer simulation.

Chapter 4. Conclusions and Recommendations

Conclusions

This chapter comes back to the original issue: what is, or can be, the impact of computers in education, particularly in the teaching of the social sciences at the secondary school level? The basic thesis, which included six general questions to be explored relative to a general contention that computers can be used effectively in teaching social studies concepts was presented first. Testing began with a specific case study involving the use of a spreadsheet and graphics program to teach the interpretation of statistics in economic geography. Students were also given a computer simulation which required them to apply what they had learned in the first exercise to a model developing country.

In the practical case study, measured results were two to three percent higher than were the general averages in social studies for the classes in question. These differences do not appear startlingly great. It must be remembered, though that these results are largely based on standard testing procedures. As such, they fail to take into account two important factors: student attitudes and long-term retention, particularly of basic concepts and relationships. Student attitudes and long term retention, I would suggest, are the very areas in which significant differences may occur.

Unfortunately, the confines of my study did not allow me to measure these two factors. But surveys and phenomenological observations do shed some light on the attitudes and approaches of the students. These will be considered in two contexts: (1) in terms of criteria established by educators from a practical standpoint, and (2) in terms of learning and information theory. I will then follow with some observations on retention, related to learning theory and information theory.

Students [illegible]onded positively to both the computer-based statistical analysis and the [illegible]nputer simulation relating to a developing country. In the case of the students' statistical exercise, they manipulated data from a table presented to them and in a few instances either added or modified data. It may be argued that interaction with the data is something they could do without the computer by being asked to interpret either statistics or graphs that had been presented to them in a book. This is true; but, with the computer, at least two important differences occurred.

First, the students were neither required to perform manual mathematical calculations nor to draw graphs manually. Yet they definitely did interact, by formulating particular hypotheses and constructing graphs based on the statistics to test their hypotheses. Because of the ease with which they were able to re-arrange data and draw different graphs, they were freer to focus on the social studies related concepts and relationships with which they were working. They were not sidetracked by the mathematical tasks and manual graph construction which would have been necessary without computers. Given this freedom, they seemed to speculate freely and tried a variety of approaches. When they did come up with a configuration with which they could work, it was a product of their own reasoning, and they identified with it.

This conclusion might be criticized on the grounds that students could abandon hypotheses that did not work, searching until they found one that would work. A few students did this, but they were also encouraged to seek explanations of why ideas they had originally harbored did not work. Proving a hypothesis wrong could be every bit as valuable as apparent statistical confirmation of the hypothesis. (See my later section on inductive and deductive reasoning.) In either case, they received positive re-enforcement in the form of the clear, neat graphs they had constructed. Being able then to provide explanations of their findings in their written reports added to their sense of possession and accomplishment.

Students appeared to have internalized the logic relating to the relationships with which they had been working. A good test of this would be to come back to them at a later date and ask them about their work or even about the interpretation of statistics and graphs generally. Unfortunately, this was not possible, though such an approach might be appropriate in some future study. What was evident was that, when talking after the exercise had been completed, the students were able to defend their conclusions. They were also able to show insight into the strengths and weaknesses of computers, graphs and statistics. No longer did either computers or statistics leave them in awe of some mystical "truth" as is so often the case with students who are not familiar with computers or statistics.

A significant part of the explanation of the students' grasp of the significance (or lack thereof) of statistics and graphs can be attributed to the fact that not only did they manipulate information given to them by drawing graphs, but they were able to actually manipulate the statistics. Such manipulation ranged from sorting data to adding new data from other sources.

This endeavour all began innocently enough. Students were asked to correct a spelling error that had inadvertently crept into the column naming countries on the spreadsheet. The students picked up on this procedure quickly, and I went on to show them how to add new columns of data, suggesting some sources they might find useful. While not all students took advantage of this, some did. The net conclusion by the students was: "I am the master, not the statistics or even the computer!" This appeared to be the second major difference from working with books. Students could not only work with what had initially been presented, but they could relatively easily change and add to it. It is true that some of the manipulations students performed could have been done manually, but not with the ease afforded by the computer. It is also significant that students who had previously displayed little initiative to think creatively now entered a new and exciting world of exploration. These were the students who turned out to be most enthusiastic at the end of the exercise.

Communication by spoken language is interactive, at least at the personal level. Through this interaction, we have overcome some of the barriers to ideal communication. Yet through technology, by making much of our communication passive, at least to the receiver, we have often posed new barriers. A goal which might be set for the computer is to overcome some of these barriers.

In learning to master abstract concepts, the student passes from rote memory through various stages of internalization and critical thought, for example, in Bloom's taxonomy of cognitive thought (Bloom, 1956). Barriers may appear at various stages, in the form of either communication breakdown or failure to perceive interrelationships, to apply knowledge, or to synthesize it. To overcome these barriers, the student must work actively with the information. This work can be done in many ways and on many levels.

The computer provides one vehicle for such interaction, at a highly sophisticated level. My case study, particularly that involving working with statistics in economic geography is a case in point, although the computer simulation also does this. But the students were able to skip the detail of the mathematical grammar and move directly to a pictorial representation of their ideas. The students tied pictorial or graphical presentation to language in the conventional sense when they wrote up their results. Use of the computer might actually be considered an extension of language and grammar.

Although my case study began simply as observation and interpretation of students' interaction with computers, I was drawn to explore the relationship of their learning activities in that context to theories of learning and language. I explore this in some detail in the epilogue (chapter 5). What appears below is largely a summary of my conclusions about the relationship between the case study and the theories explored in more detail in chapter 5.

Intellectual entropy[1] gave way to order as students tested and evaluated relationships. Perfection of communication would likely never be reached, but students gained ground in this direction by expanding their comprehension through manipulation of the statistics and constructing graphs to test and illustrate their findings. Interpretation and redundancy may be given credit here. Students were expressing ideas in different forms. In so doing, they tested whether the ideas could withstand the rigors of translation from one form or

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[1] Entropy refers to disorder among molecules in physics, which disperses energy within the material, rendering that energy unavailable for use. Intellectual entropy would involve disorganized information, which, due to its lack of order, has not been organized into meaningful or usable knowledge.

language to another.

When I began this study, I was not familiar with the views of Popper. I was, however, disturbed by the classical approach of Bacon and Mill that through deduction we can seek to verify theory. Problems with this classical approach haunted me as I watched the students tackle their tables of statistics. They would identify a hypothesis and then seek to prove or verify it with the statistics. Frequently, they would find that most of the statistics they used fit, but not all of them. Students were trying to reason inductively from the specific to the general; and, when they found exceptions, they were inclined to give up if frustration.

On reflection, I came to believe that this was the first time students had tackled the challenge of sophisticated theory testing in the social sciences. At first I was intimidated, as were they. They were dealing with a level of abstraction seldom approached in high school social studies program.

True, earlier students had encountered apparent anomalies such as the graph of birth and death rates in England which appeared in the old textbook, Population and Production (Smith, 1971). The birth rate, after a long period of decline, took a sudden jump around the time of World War II. This apparent contradiction was explained away as being a result of the war. Students passively accepted this explanation.

Now, they faced anomalies accompanied only by raw data. How could this be handled? I encouraged them to find out as much information as they could about the anomalies they found. They were forced to try to determine whether the anomaly did indeed contradict the theory or whether circumstances previously not identified permitted the theory to hold. In fact, they had to reason deductively. As long as a general relationship was not disproven, it was tentatively accepted. Something did not fit. This was not deductive reasoning. Yet surely the hypotheses the students were testing were tentative. The students had begun with a generalization, which they intuitively accepted. Only decisive evidence would be that which proved it wrong. Until that was found, it must be tentatively accepted.

This idea fit Popper's contention about deductive reasoning. The search is not for confirmation, but for contradiction. This search was, in fact, what the students ended up doing. In itself, the search was educational, but what did the computers have to do with it? In a direct and obvious sense, not much. In a less direct sense, the use of computers helped students shed the naivité of their blind faith. They could test voluminous statistics with relative ease. Yet unencumbered by the drudgery of detail, students could see the broader picture and check for inconsistencies, which they would then pursue by a variety of means. They were learning more than concepts, they were learning process on an impressively high level. In fact, without fully realizing the depth and significance of what they were doing, they were enjoying it and taking pride in their accomplishments.

This sounds too good to be true and in an important sense, of course, it is. Such learning experiences don't just happen. What my study demonstrated is that the computer can be an aid in extending thought processes and, with them, learning. By virtue of permitting extensive interactivity in information handling and making possible relatively easy complex manipulation and molding of that information into new knowledge, the computer does indeed possess the potential to aid in education. Not only does it help do old jobs better, it facilitates new approaches such as bringing to lower levels of education processes previously expected only at the post-secondary level.

My relatively simple use of computers is just the tip of the iceberg. Such innovations as interactive laserdiscs and broadly based networks linking people and databases over wide geographic areas as well as the rapid updating of information bases (databases) and their dissemination to masses of people have not yet even been touched here. But these developments are coming, despite some of our protests. So, where to from here?

Recommendations

If this study has any significance it must be measured in terms of its contribution to improving education and doing so in the context of recognizing the potential of the computer to do so. A number of recommendations emerge.

First, computers should be treated in the school system as more than extensions of existing teaching methods. They must be made available to students in a variety of subject areas, not the least of which is social studies. Databases should be made widely available to students, and teaching should involve more than using computers for information searches, though this is important. Computers must also become an integral part of process. Students must be taught the potential of computers in reshaping informational entropy into order, into knowledge. At the most shallow level of such reshaping of information is the role of computer simulation. Student control at this level, while valuable, is still externally directed. Handled well, computer simulations can motivate students to test their ideas and to encounter a variety of outcomes. Ultimately, computer simulation still leaves them at the mercy of a master, the parameters built into the simulation.

Far more promising for its open-endedness is the practice of exposing students to a variety of information sources and the opportunity to mold information from these sources into understanding and new ideas. This task requires a melding of the computer and the teacher. Neither the computer nor the teacher can do it alone. The teacher must be prepared to show students what computer-based information is available and how to access it and transform it into knowledge with the aid of the computer (also in conjunction with more conventional sources). This sort of teaching requires both improvement of facilities and teacher upgrading.

Secondary schools should make banks of computers and, ideally, printers and modems available to students in a variety of subject areas. Such an expansion of computer resources for classroom use need not be as imposing as it sounds -- one Edmonton high school at least (Ross Sheppard) already has this: three computer labs each capable of handling 32 students and six word processing oriented computers and a student-accessible modem with access to the CanOle and ERIC databases in the library. Teachers also need to become capable of handling such facilities and more able to teach students to do so. The teachers should also learn to teach students how to use relevant computer applications: databases, networks, and spreadsheet/graphing programs.

The greatest challenge is to explore the real potential of computers in education. The question is not "How can we use computers to do our present job better?" The questions are, rather: "How can we use computers to help students extend their learning parameters? How can we help students learn the potential and limitations of computers in learning and in the practicalities everyday life?

Perhaps this study helped answer a few questions; but, also, I hope, it will raise a number of new questions. I have proposed one approach to tackling them. I can only hope that others are encouraged to pursue this challenge.

Chapter 5. Some Observations on Learning Theory and Computers

Introduction

As I reviewed my study of the use of computers in teaching grade 11 social studies, I became increasingly aware that in my mind I was addressing a topic that was not readily apparent in my written work. What was bothering me was not just the question of whether computers would be useful in the classroom. If indeed computers would be useful as described in the study, why would they? Intuitively, I was convinced that what was involved was not just another mechanical device superimposed on the conventional teaching/learning process, but rather an extension of thinking and communication, which meritted consideration in its own right. In an important sense, language itself was being extended, and through the extension of language, the very process of internalizing knowledge was acquiring an added dimension. To explore and/or explain this dimension would require a paradigm that included communications and learning theory. That paradigm is explored, albeit tentatively, in this chapter.

It is tempting to view computers as simply another technological device in an age of purvasive technology, having made their way into the classroom as they have into the workplace. But the impact of computers goes beyond that. The printed word was a major factor in the information revolution that was central to the European Renaissance. Similarly, the computer is inextricably bound up in the information explosion of the Twentieth Century. But is the computer a harbinger of entropy in information, because the body of information that it can handle is so massive and still growing that information is out of control; an actual impediment to the expansion of knowledge? Or is the computer simply a very useful vehicle for organizing, manipulating, and transmitting information in a such a way as to extend knowledge and interpersonal communication on a level significantly higher and more comprehensive than was ever before possible?

If Twentieth Century society is to harness the computer to help us to manage information, then that society would do well to consider the role of language and communication in such a pursuit and to consider the potential of the computer in this context. This chapter will explore briefly the general philosophical paradigm of language and culture, and the potential impact of this new information handling device, the computer.

Communication, Culture and Computers

The computer is an information handling device. As such, it is a vehicle for and shaper of language and communication. This fact is so basic that it could easily be overlooked. Yet, to assess the impact of the computer, it is useful first to agree on what is involved in the job we have assigned to it. The formation and communication of ideas and knowledge is as old as civilization, and for that long have people struggled with the question of how the human race thinks and uses language to communicate thought.

In speaking of thought and language, Plato employed the concept of forms. To him, forms were ideas that precede physical reality. They could be logical, metaphysical (that which is ultimately real), epistemological (that which is known), or moral. But forms themselves were abstract ideas. First spoken language, then written language facilitated the communication of ideas. Written language not only added a visual element to the oral, but allowed for amassing of recorded and stored information.

Both oral and visual language have varying levels of abstraction, particularly with the use of metaphor. At first, an important difference with the inception of recorded language was that the written element physically removed the receiver of the message from the sender. Recently, the essentially Twentieth Century elements of audio and video recording have permitted the return of both physical and verbal nuances to the communicator. Yet, audio and video recordings continue to leave the receiver relatively passive. The pattern of the message is set by the sender, and this pattern cannot easily be modified by the receiver. For example, the viewer of a videotape can fast-forward or reverse the tape, to particular sections, but the process is slow and fairly inexact. The videotape itself does not track the viewer's progress, nor does it respond to the input of the viewer. The message is essentially packaged and sent by the creator or sender of it. The receiver can analyze it in his/her own mind, but can do little else with it.

Computers and electronic information management are changing that. Like the telephone, the computer, when linked with other computers, lets sender and receiver interact, essentially directly and instantaneously. The computer also permits the receiver to interact with the message relatively easily and quickly in yet another way. The person receiving the message can now also manipulate it. This manipulation occurs not just internally, as when he or she thinks about it, but also by reshaping, analyzing, and synthesizing done externally -- by the computer itself. The ability to manipulate a message with a computer forces us to ask an important question. Does this mechanical/electronic device remove the receiver yet one more step from the original message, or does it facilitate internalization by making the person receiving the message become interactive with it? To facilitate dealing with this question and other issues, we must first consider the impact of the age of science on epistemology and information theory.

Epistemology and Information Theory

Epistemology got off to a stilted start in the so-called modern era. It could be argued that it has not yet recovered. Renaissance humanism gave way to

Cartesian dualism and the mechanistic view of philosophers who read more into Newton and Darwin than either of these men perhaps ever intended. One illustration of this mechanistic philosophy is the metaphor of the Creator as the blind watchmaker in a mechanistic universe. A shining exception to this approach is the Neopolitan philosopher Vico, who commented:

> In the night of thick darkness enveloping the earliest antiquity, so remote from ourselves, there shines the eternal and never failing light of a truth beyond all question: that the world of civil society has certainly been made by men, and that its principles are therefore to be found within the modifications of our own human mind. Whoever reflects on this cannot but marvel that the philosophers should have bent all their energies to the study of the world of nature, which, since God made it, He alone knows; and that they should have neglected the study of the world of nations or civil world, which, since men had made it, men could come to know.
>
> (quoted from Pagels, 1988, page 214)

As problematic as Cartesian dualism is, within it may rest the seeds of a solution. Descartes separates the world of nature from the world of human reason. It is his modern successors in computer science, psychology, and the neurological sciences who have tried to define artificial intelligence (intelligence simulated on a computer) and link it by metaphor to the human brain. In so doing, some computer scientists pursuing artificial intelligence seek awkwardly to accommodate an approximation of human intuition within the confines of parallel processing. Parallel processing is a new approach in computer processing which involves some highly sophisticated computers pursuing several paths of interrelated logic virtually simultaneously. Surely Descartes himself would reject the gargantuan leap of logic made by the computer scientists, settling instead for his own famous dictum, "I think, therefore I am." Kant too espouses a dualism which accepts both the theoretical reasoning of science and a practical reason of the lawyer, the businessman, and, indeed, the exigencies of everyday life.

The Computer and Human Thought

If we are to use the computer to best advantage, we must sharpen our perceptions both of it and of human thought. Some modern scholars of linguistics, learning theory, and the philosophy of science are addressing this complex task, though often in conflicting ways and often without direct reference to the computer.

We must remember that the computer is performing two related but different functions, both under the tutelage of humans. First, it is used to assemble, organize, store, retreive, and transmit vast amounts of information; and it is able to do so with amazing speed. This facility is a revolutionary jump from its predecessor, the printed-word in mass-produced-books. The reorganization and updating of data are much more easily accomplished with computer-based digital storage media and these media can store vast amounts of information in extremely small spaces. For example, a disc the size of a compact disc has been used to store the enitre printed contents of Grolliers Encyclopedia. Like books, the computer is both a product of and a creator of an information explosion. Both books and computers may be seen as inventions brought about by necessity. As humanity's grasp of information expanded, so to did our need for more efficient ways to store and transmit it.

The second function of the computer is that it manipulates information in manners never before possible. Herein, it satisfies a new need. The sheer volume of newly acquired information at least poses the danger that we will lose control and become buried by the avalanche. The computer not only reduces storage space, but permits rapid, apparently random access. However, this access is in an important way not random at all. Searching is done by processes, formulae, and keywords, imposed by human masters. Again, the example of the encyclopedia on a WORM disc[1]. By entering keywords on the computer, the user can, in a matter of seconds, access any or all references to the topic identified by those keywords throughout the entire encyclopedia.

One must also recognize that searches using key words may create distortions. Isolating small chunks of information from the broader context in which the author originally placed them may cause the user of the information so acquired to miss the intent of the original author. The user of this process therefore has a responsibility to be aware of the potential for distortion that occurs any time something is quoted out of context.

The computer facilitates relatively easy transformation of information from one mode to another (e.g. from statistics into graphs), mathematical manipulation, and sorting into new patterns. Such a device is bound to affect and enhance human thinking. Such manipulation in fact was what was being done in my case study.

The challenge is not to get the computer to replicate human thought, though that may come later, or even to provide a metaphor for human thought. The challenge is to understand some of the potentials of the computer and to harness it to extend thought, just as Galileo used the telescope to extend his sight to the heavens. This in essence is what I have sought to do, albeit in a relatively modest way, in the statistical exercise with my social studies students.

It would be short-sighted to study the impact of the computer on one

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[1] Write Once Read Many times disc; a disc similar in shape and operation to the compact discs commonly used in music recording. It has the advantages of storing vast amounts of information in a small space and making random access possible, but the disadvantage of permanency. Informaiton on it cannot be altered.

social studies topic and miss the social study of the computer on humans generally. Certainly, even before deciding to conduct this study on my own classes, it seemed most reasonable and correct to read those writers and thinkers who have discussed computers.

After considering briefly some of the major postulates of people like Popper, Chomsky, Piaget, and Habermas, we can perhaps sort out current thinking , knowledge, and learning about how to incorporate the computer into the extension of learning and thinking in a manner that will render the mind and the machine compatible, all be they strange bedfellows.

Karl Popper

As a philosopher of science, Karl Popper has tackled the basis on which scientific knowledge is pursued and developed. He breaks knowledge into three worlds: 1. the world of physical objects and physical states; 2. the world of states of consciousness, mental states, and behaviorial disposition to act; and 3. the world of objective knowledge -- a world of theories, of problems, and of arguments. In the context of objective knowledge, he maintains that we have an inborn expectation for order and logic. On this point, he appears to agree with Kant, who maintained that we begin with *a priori* knowledge, which is acted upon by sensory input. But, to Popper, our *a priori* knowledge is tentative and conjectural rather than absolute, as Kant had supposed. Disappointed expectations of finding a particular order as set out by a hypothesis constitute a problem for us. To deal with this problem, we come up with new conjectures, new hypotheses. Unbeknownst to themselves, this is the world in which my students were operating in their computer assisted statistical analysis and to a lesser extent in the computer simulation, "Decide, Your Excellency".

According to Popper, we must accept that knowledge is never absolute. Popper calls such an approach critical rationality. He maintains that we should give up the search for justification of knowledge and replace it with a search for errors and inadequacies. Finally, we should only tentatively accept that which has not yet been falsified.

In fact, as his example of the white swan illustrates, Popper's logic is deductive. He begins with the proposition that all swans are white. If that is true, then any particular swan will be white. But as soon as a person finds a black swan, the proposition is disproven and must be modified to accommodate the black swan. Thus, Popper says, humans reason from the general to the specific.

My students reasoned the same way. They did often try to resist, being tempted to select only those data which confirmed their hypotheses. But they could see the merit of accepting a disproven hypothesis as evidence of an advance in their knowledge. The students' initial discomfort was understandable. They were operating on a level that they had never experienced before in social studies.

In his theory of the three worlds of knowledge, Popper maintains that technology is part of the first or physical world. However, the use to which we put it links it to the third, or ideational world. He uses the example of a book to illustrate this point. A computer could equally well be used to illustrate this point, but our interaction with the computer is very different from the relatively more passive, linear interaction common between reader and book. True, the reader of a book can take notes, highlight sections, and even move back and forth from one section of the book to another. In the case of the computer, however, a good instructional program will track the student's progress and mastery of the material, and customize routing through the program depending on the level of interest and mastery of the student. A good instructional program will also provide opportunity and encouragement for the user or student to move frequently and with ease to various other parts of the program.

Social Science and Communication

To get more of the story, we must also look at how some others view knowledge and its extension. Karl Popper is concerned primarily with scientific thinking, whereas Naom Chomsky and Jean Piaget are concerned with the acquisition of knowledge. Jürgen Habermas, in his critical social theory, focuses on interpersonal communication and its relationship to class structure in society. Chomsky also addresses class structure in some of his writings. He does not address it directly in the passages with which my paper is concerned, although his thinking must be influenced by his social concern. What emerges in a study of the insights proffered by all of these men is a sometimes delicate interplay between social science concepts and communication.

Language is an important factor. I will explore the extension of language through computer technology and the relationship between this extension and the study of the social sciences in the high school. In viewing the linguistic theory and learning theory of Chomsky and Piaget and the sociology of Habermas, I hope to set forth further information related to my conclusions concerning the role of computers in formal learning related to social studies.

Naom Chomsky, Language and Computers

Naom Chomsky tackles knowledge through linguistics. His theory of innate knowledge runs counter to Popper's concept of three worlds. To Chomsky, the environment itself does not have a structure that is readily apparent to the organism or person. Laws of order or grammars, be they biological, cognitive, or linguistic, come from within us and are imposed on the external world. These laws are universal to the species and innate to it. They are invariant over time and across individuals and cultures. To Chomsky, the question is whether there are, within individuals, uniquely human "grammars" that generate not only language in the normal sense, but other complex kinds of knowledge and languages such as music and art.

Chomsky introduces the "ideal speaker" whose grammar is universal to the human species. Chomsky postulates a generative-transformational grammar, which includes, in his terms, both surface structure and deep structure. The surface structure is recognizable in the transformation of a sentence, for example, from the active to the passive voice. Deep structure includes phrase structure rules, which establish basic meaning. Chomsky alludes to the speaker-hearer's competence and knowledge of the language being an important component in facillitation of communication, but I have not seen this idea adequately explained. Chomsky does comment that linguistic competance is neither presented for direct observation nor extractable from data by inductive procedures of any known sort.

In exploring Chomsky's contention that linguistic competance plays a significant role in communication, information theory may provide useful insights. In information theory, entropy is the tendency of things to move toward disorder when left uncontrolled. This concept is held to be particularly true in physics, but can be applied in other areas as well. Claude Shannon, while working for the Bell Laboratories in the 1940s, tackled the problem of noise in sending electronic signals. In vastly oversimplified form, his contention was that signals appeared to move toward increasing entropy as noise increased in both a literal and a figurative sense. But if one could sift out the noise, there remained a clearly discernable message. Understanding how the message was encoded in the first place would provide the receiver of the message with a tool vital in decoding it.

Shannon was shocked by the publicity his work received and cautioned against generalizing from it. But there is no denying its appropriateness to Chomsky's linguistic theory. Both Shannon's theory of information and Chomsky's theory of language are concerned with source rather than with output. The message system as a whole rather than individual messages would be the focus of their attention. To Chomsky, the individual person would be a kind of decoder. As the message moves from the source in the brain of the sender on the journey to the person for whom it is intended, it becomes distorted in various ways. Distortions, or noise, could take the form of mistakes, slips of the tongue, memory lapses, repetitions, and so on. Chomsky sees syntax and form as elements in an information system that reduce entropy and separate messages from noise.

Redundancy, though it may not be of major interest to Chomsky, can also be another entropy reducing device. And redundancy, though of limited application in the linear presentation of messages in most audio visual media, can easily be accommodated by the user of the computer. It can be agrued that the mind of the receiver of computer-based messages can analyze and interpret the messages and he/she can extract and manipulate information, in this manner breaking free from the linear presentation. But the receiver can also extend his/her ability to extrapolate and interpret the information when the computer is the vehicle through which the informtion is presented. The receiver or decoder of the message can test the message by using the computer's capability for random access to approach the message again and again, perhaps from different angles. Redundancy, under the control of the receiver, is achieved by this process. Because the process is initiated by the receiver and is easier and more extensive than could be achieved without the computer, the message more truly becomes the property of the receiver and is more effectively internalized by him or her than would otherwise be the case. Redundancy in the sense of reveiver generated reorganization of information from statistical form to graphical form was central to the project on which my students operated.

Chomsky has been criticized for focussing on grammar to the exclusion of culturally derived concepts which vary from one language to another. He responds by pointing to the danger of not seeing the forest for the trees -- of ignoring the universals in linguistic structure in favor of culturally imposed details. The electronic media may provide the link which encourages the focus Chomsky wants. Television and radio appear to be facilitating extension of an international and inter-ethnic level in culture which transcends geography and ethnicity as well as language. As cultural barriers erode, Chomsky's concept of a universal grammar assumes new significance.

However important such a trend initiated by radio and television may be, those two media appear by the 1990s to have been only the tip of the iceberg. Fax and computers have captured the interest of business, academia, and the public generally. These two electronic divices are providing new links, the flexibility and popularity of which render them extremely powerful vehicles for information sharing. But just as the technology involved expands the horizons of communication, that technology also establishes some important basic rules and constraints of its own.

At least at the programming level, the computer imposes constraints related to programming languages, particularly evident in the tight logic of such computer languages as BASIC, C, and Pascal. But as computers become more sophisticated, these constraints need not overly concern the lay user. Rather, the user may see the computer as an extension of human language. The question of computer generated translation between human languages which may preclude nuances of interpretation is another matter. What is of concern here is the role of the computer within the context of a particular language. The constraints as well as the extended opportunities which come with such computer use promise to contribute to the generalized worldview born of electronic communication media.

If we extend communication beyond the oral, the question of the relationship between thought and language assumes increasing significance. The introduction of the written word, and even more dramatically the use of movable type and mass produced books, made necessary the introduction of standardized spelling and grammar, for example. Whether or not such standardization influenced patterns of thought, it did clarify linguistic communication.

If ignoring the relationship between thought and language was dangerous in the past, this danger increases as the computer indroduces new ways to develop and communicate ideas. Teachers of computer science have noted that even students who have had trouble with English grammar often quickly recognize the need for clearly defined grammar in computer languages. Frequently, these students then develop a new appreciation and understanding of English grammar.

But the student need not go as far as developing competence in computer programming languages. Many students in my classes seemed to develop an intuitive grasp of the patterns and limitations of the computer programs which they were using. What they usually failed to recognize, though, was that the grammar related to the computers was created by computer programmers and it was tailored to the logic of the computers. They did not appreciate that this grammar, contrary to surface appearances, was not intuitive and creative. Intuition and creativity remained in the minds of the computer user.

If Chomsky can demonstrate a universal linguistic grammar instrumental in shaping human thought, then understanding its ramifications should help us shape and extend computer-based information handling in such a way as to accommodate his insight into human reasoning. Whether such a grammar is innate to the human mind could be considered academic. The significance of such a grammar could rest not in its source, but in its process and, ultimately, in its ability to facilitate thought and communication.

Piaget, Learning Theory and Computers

Unlike Chomsky, Piaget downplays innatism in human thought and language. Instead he prefers to describe three stages of intellectual development: sensory-motor, concrete operational, and formal operational. According to Piaget, learning ability develops sequentially, as the child passes from one stage to the next.

Abstract thought, first evident at the concrete operational level, matures during the child's adolescence when formal operational thought emerges. In commenting on reflective abstraction, Piaget once again breaks his concept down into three parts, each more abstracted than the previous one. Empirical abstraction relates to physical objects external to the subject. Reflective or logico-mathematical abstraction proceeds from the subject's actions and operations. Finally, reflected abstraction or reflected thought involves the thematization of that which remained operational or instrumental in the reflective phase. But reflected abstraction also presupposes a set of explicit comparisons at a level above the "reflections" at work in the instrumental utilizations and constructions of the reflecive phase. To Piaget, learning progresses not through innate capabilities alone, but through increasingly sophisticated contact with the environment.

Piaget's theories about reflective abstraction appear in a significant way to parallel Popper's three worlds of knowledge. Piaget postulates his theory from the basis of his belief that life is a gigantic information flow that mediates the transition of the "entire universe" from an initial less organized state to increasingly more organized and stable steady states. Logically then, knowledge is information that has been organized into orderly patterns by the human mind. There is clearly a role for the computer as a tool for the extension of human thought in its organizational and manipulative information handling capabilities. This is the role the computer was playing in the exercises performed by my social studies students.

Jürgen Habermas, Social Theory and the Computer

Jürgen Habermas, commonly associated with the Frankfurt school of critical social theory, takes a hermeneutic approach to sociology and philosophy. For Habermas, legitimation means to be justified or acceptable for the human mind or for society. For him, the leading productive force in society -- controlled scientific-technical progress itself -- has now become a basis for legitimation. The information society must justify itself and share the mantle of motivation with other forces such as ecological concern and self-actualization through creative thought beyond the industrial-scientific context. It would be an over-simplification to stop at acknowledging the neo-Marxist bent apparent in much of what Habermas has to say. His work establishes a paradigm compatible with an information-based society such as that emerging in the late Twentieth Century.

Habermas a.Three Types of Knowledge

Just as Popper has identified three areas or types of knowledge, so has Habermas. However, contrary to the claims of some of his critics, Habermas endeavours not to base his reasoning on *a priori* assumptions. Yet *a priori* assumptions do seem to be present in his discussion of knowledge. To him, the first form of knowledge, that associated with empirical analytical science is a world of facts, and, incidently, presupposes a human interest, the technical interest. This technical interest involves things, events, and conditions which are capable of being manipulated, and its criteria of validity revolve around hypothetico-deductive theory testing in experimentally reproducible conditions. Being primarily instrumental, its *a priori* motivational context can surely be justified if not explained as a bridge between consciousness and satisfaction of needs or desires. It could be argued that lower levels of human interaction seldom move beyond this almost reflexive mode. As civilization progresses to more sophisticated levels and humanity ascends Maslow's hierarchy of human needs, the pre-eminence or at least significance of this level of cognition and communication recedes.

Habermas identifies a second form of knowledge: historical-hermeneutic knowledge rests in the realm of successful communication in the species (human) universal characteristic of language and is characterized by speaking and acting persons using symbolic communication. Its criteria of validity involve agreement between partners in a situation of dialogue. From this form of knowledge social consciousness emerges. Social consciousness is not an*a priori* justification.

Habermas identifies a third form of knowledge: self-reflective knowledge.This knowledge includes critical social theory and involves an emancipatory interest, aiming at the realization of autonomy and self-actualization. Language, the complex and fragile vehicle of communication, may not be up to its task at this level. Actions and utterances may be distorted, requiring explanatory understanding, which is neither purely causal nor purely interpretive. In discussing the complexities of self-reflective knowledge, translation from Habermas's native German to English breaks down. His notions of *verstehen,* translated roughly as understanding, may involve comprehending, or literally accepting the truth or validity of, or a kind of emotional or empathetic appreciation of the meaning being communicated. Shared meanings seem again to be the key, but Habermas seems unable to satisfy his critics on this problem.

Habermas b. Models of Communication

Certainly, Habermas recognizes the existence of a crucial problem, which he tackles in terms of communication models. The success of communication is judged by the agreement between speaker and listener on intersubjective meaning, that is, agreement in what each person thinks the other person means. Consensus in determining intersubjective meaning is relatively easy to establish at the lowest levels of understanding, personal (internal) and explicative. Both of these levels of understanding rank low on Maslow's hierarchy of needs.

In matters of practical and theoretical discourse, communication is not so simple. In practical and theoretical discourse, consensus presupposes contextural equality and the issue arises whether equality of position or merely equality of opportunity is a necessary precondition for successful communication. Intuition suggests that equality of opportunity should be sufficient, but this suggestion precludes sophisticated nuances which may be instrumental in establishing the commonality of context needed to render the degree of accuracy desired by those in communication.

Habermas claims that only generalizable interests can or will emerge in the ideal speech situation. Compromise, as opposed to genuine consensus, indicates an eliminatable imperfection in the rationality of normative decisions. Compromise is like an agreement to disagree; it is a recognition that consensus cannot be achieved. He also says that compromise indicates a departure from the ideal consensus situation based on the competition for scarce goods. Apparently the result is inequality of physical wealth, which, Habermas might argue, breaks down intersubjectivity. But this strategic action is distinct from fully rational discourse. Overcoming that problem is a tall order.

Habermas c. Technological and Social Change

The technological capacity for producing an abundance of wealth, even given the limited availability of physical resources, now exists in advanced industrial economies. However, choices about what to produce and how to distribute it remain in dispute. In this context, an emerging information society provides an added dimension as we rise to the top of Maslow's hierarchy and the standard economic choice related to material wealth becomes a consideration subservient to identification and valuation of knowledge in a bountiful information marketplace. The management of information and knowledge, as well as communication or sharing, and the manipulation of this knowledge assume new importance as both economic and philosophical issues.

On a related issue, Habermas also grapples with social evolution. He states that labour and language are two irreducible facts of any society, and that all social and cultural development are a result of these two facts. He distinguishes social evolution from biological evolution in that a reconstructed social history of the species is possible. Reconstruction of our knowledge of physical occurances or conditions does not change those phenomena themselves, but reconstruction of our knowledge of humanity based on higher levels of understanding of cognitive and affective thought does change the nature of humanity itself. And, such change also changes the values and goals of society and, hence, civilization itself. (See Vico, page 44)

Key to social evolution is the development of learning capacities. Empirical-analytical knowledge promotes a change in the relations of production and sets the scene for advances in moral-practical insight which permits new levels of social-normative knowledge. Social integration is a result of communicative action associated with advances in social-normative knowledge.

Habermas speaks in terms of late or mature industrial societies, and largely in terms related to neo-Marxism. His critical-analytical, somewhat phenomenological bent, though, can readily accommodate a paradigm shift to permit consideration of the emergence of a "third wave" of civilization, a post-industrial era in which the forces of production advance from material goods to information. Such a paradigm shift need not be ideologically bound. Within limits, the forces of production continue to include industrial goods, just as agriculture did not disappear as the industrial era developed.

Habermas d. the Information Society

In early Western, industrial society, individualism and humanism were driving forces. But, as Western society matured, these forces gave way to massification and conformity. The post-industrial or information society can bring with it a re-emergence of individualism and humanism. Material wealth, the driving force and shaper of class structure in much of Western industrial society, now recedes somewhat into the background as knowledge transcends both material wealth and tradition as the driving force in society.

Power appears to be passing from the controllers of physical wealth to those possessing knowledge. In the early stages of the information society, great value continues to be placed on material wealth, but the role of knowledge and technology in producing that wealth is increasing as capital becomes more knowledge- and technology-intensive. As knowledge passes from one person to another, it is not lost by the first person. Knowledge, then, is not traded or hoarded as material goods are. As values and class structure in society change to accommodate a shift in emphasis from material wealth to knowledge, the way people think of knowledge is also changing.

According to Thomas' law, as people think, they act accordingly. In the area of human behaviour, it doesn't matter what is real or true. Implicitly, reality and truth are in some way objective; but in fact, Habermas would suggest that the nearest we can come, or indeed have need to come, to objectivity, if it exists, is the intersubjective truth of the ideal speech situation. In any case, given Thomas' law, education becomes a powerful tool in shaping the destiny of both individuals and society because education makes a significant contribution to the molding of human thought. But our concern is not only with a behaviorist notion of action. It is also, and more importantly, with individual and social consciousness.

Habermas and My Case Study

The preceding discussion of Habermas may at first appear unduly protracted and even irrelevent. However, the value of considering Habermas' work is that it ties together the previous theoretical discussion and practical concerns in education as illustrated in the case study of computers in the social studies classroom described in Chapter 3. He is, in fact, exploring a new paradigm in which knowledge and social consciousness transcend material wealth as organizational and motivational factors in society. The role of computers, including computers in education, in this paradigm is a key one.

The computer can be a great leveler in a society whose social structure is shifting dramatically. In the industrial society, material wealth was largely the basis of a dominant middle class. That middle class could be threatened as power shifts from a material base to an information base as mentioned by Shirley Carr, in Critical Choices (Wiseman et al., ed. 1991). In the shift we could lose the intersubjectivity so crucial to the industrial middle class. Instead we could find emerging a powerful but small information elite and a large, relatively disempowered lower class.

Or, we could use the technology of communications to bridge the gap and permit large numbers of people to benefit from the wealth of information (ambiguity intended) promised by an information society. The computer may be the tool we need to do it. And as the case study illustrated, within limits at least, this can be done. The interactive nature of the computer based information handling is a powerful motivational tool to students, as I found in my case study.

Powerful too is the capacity of the computer to facilitate students' comprehension of social phenomena as evidenced in their manipulation of statistics in the case study described in chapter 3. That enhanced intersubjectivity was a product in the case study comes as no surprise. Redundancy in communication as illustrated by the transformation of statistics into graphical form was a key tool in this process. Flexibility in manipulation of informaiton was another. Transformation of information into knowledge was a result. And all of this is entirely consistent with Habermas's critical theory.

Language and Culture

Language and culture are two major determinants of consciousness. Where language remains the major vehicle of education, cultural reproduction and cultural change provide a major *raison d'être* for education. Obviously, at no time in any society is the role of education more important than during a paradigm shift or dramatic redirection of the very informational foundation upon which that society is based.

In terms of the traditional functions of education, the broad perspective of change imposed by the shift from an industrial society to an information-based one is fairly clear. Education as human capital or force of production, must provide the student with an enhanced technological literacy capable of coping with information technology. In the environment of rapid change inherent at least in the early stages of the information era, education must prepare the student for technological literacy and provide opportunity generally to acquire rapidly changing practical knowledge. The demands of changing technology will likely involve life-long education and probably a break from the industrial model of k-12. The ascendence of formal education will likely also be challenged by informal education in an information-rich environment.

Values are even more evident in the context of education as it applies to the relations of production. As the industrial era distinction between the proletariat and the bourgeoisie diminishes, the issue of access to information as a determinant of class, status, prestige, and power assumes a paramount significance: in the post-industrial or information society, abstract knowledge might logically challenge physical skill in the workplace. As the industrial society matured, the emphasis in formal education shifted steadily from technical (empirical-analytical) to practical (hermeneutic). Norms, ethics, and values, important in mature industrial societies, become pivotal in the information society. With our increased ability to exercise control over not only our physical environment but ourselves and each other, as in society at large, the weight of responsibility for our actions increases correspondingly. Equality of educational opportunity also becomes central if structural inequalities in class are to be reduced. As implied above, in the information based society, the uneducated could logically replace the unskilled as the underprivileged lower class. Left alone in this context, inequalities of educational opportunity will increase, promoting instability and perhaps revolution or exploitation reminiscent of Orwell's 1984.

Self-actualization is by definition emancipatory. It raises the individual's consciousness, reducing the constraints and limits on personal freedom. This freedom is made possible through learning that broadens one's perspective. Habermas, like Popper, recognizes the importance of this learning when he identifies three levels of knowledge: technical (empirical-analytical), practical (hermeneutic), and emancipatory (critical-theoretical). In the information society, an increasingly large segment of society may seek, and perhaps achieve, the third level of knowledge -- critical-theoretical. One can recognize the growth of self-actualization as well as social consciousness in such a context.

Habermas speaks of social evolution and the relationship of education to it. According to him, learning takes place in two central dimensions: (1) empirical-analytical knowledge and (2) moral-practical insight. Speaking of the capacity to learn, he observes that the universalist must be able to internally reconstruct knowledge without prejudicing the actual dynamics of development and without assuming that such development is either continuous or linear. Like Papert, he states that this process involves decentration of world views, or broadening one's perspective from a highly personal one to a broadly based cultural one. He adds that this must involve critical and reflective appropriation of the past. Access to the world can now be achieved through common interpretive efforts in which social actors can co-operatively and reflectively negotiate situation definitions capable of intersubjective recognition. Decentration of world views, in an important way, is what education is all about. And, in the information era, education aimed at this end is not only more important but more possible than ever before.

Habermas and the Computer

It takes no great leap of imagination to see the links between Habermas's theories and the computer. The computer can provide a real-time link between the transmitter and the receiver of information. Through this link, given the desire to do so, humans can interact, verifying and clarifying the message, transcending physical distance, just as they can with the telephone. Also, the receiver achieves a new level of interaction with the information to which he/she is exposed, being able to use the computer to search and select information as well as to manipulate it. And while the computer may centralize physical storage of information, in large computer-based data banks, for example, this same instrument, the computer, decentralizes access to information, providing opportunities for access to information literally at a world level.

If education and knowledge involve internalization and creative manipulation of information, this electronic device (the computer) and its relatives, the telephone, fax, radio, television, and laserdisc are indeed propelling civilization into a new information era. Many issues present themselves. These range from political sovereignty to economic stability and changing economic institutions. From this cornucopia I have chosen as my focus a very basic issue -- the impact of the computer on education. More accurately, I have explored two examples of the use of computers in the social studies classroom. I have used as my example the teaching of economically related demographic concepts. The job now becomes one of synthesizing and evaluating the practical and theoretical information outlined thus far in this dissertation.

Appendix 1: Statistical Assignment

Social Studies 20: Graphs Assignment
General Instructions and Intent

The intent of this assignment is to explore what relationships (perhaps, but not necessarily cause-effect) might exist between various factors present in countries at different levels of economic development. (One of the first things you will probably need to determine is what is a reliable measure of level of economic development.)

You are to test the relationships between sets of population, geographic, and economic variables. You will illustrate your findings on graphs, and give a written explanation of what you are looking for and what you find. If possible, you should try to explain why the relationship you find exists, why exceptions occur (if they do), and how strong the relationship is.

Each set you do must contain two or more variables. Some examples appear below.

1. What is the relationship between per capita GNP and birth rate? Rate of natural increase? Death rate?

2. Is there a relationship between daily food intake (total or protein) and death rate?

3. How does urbanization relate to level of industrial output?

4. What can we tell about a country by its breakdown of employment between primary, secondary, and tertiary employment?

5. Is the literacy rate in some way significant?

6. What does the energy consumption of a nation (e.g. electricity consumption) tell us about a country?

7. Is there a relationship between food requirements and something else (like geographic location or kinds of economic activity)?

8. THIS ONE IS ESPECIALLY ENCOURAGED. Determine an idea or theory of your own that might explain a relationship between two or more of the variables given. But, if you choose this one, you must get your teacher's approval before pursuing it. Permission will be based on practicality and appropriateness to issues relating to population and production.

SOCIAL STUDIES 20

Global Environment: Graph Assignment

A. Goals

To test relationships among factors relating to population, nutrition, and levels of economic development, and to illustrate findings with graphs and written explanations.

B. Resources

1. Data and information from World Prospects
2. Macintosh computers
3. Excel™ software for manipulating data on spreadsheets and constructing graphs.
4. Software: tutorial on graphs and how to use Excel™
5. Printers
6. Microsoft WorKS software
7. Apple IIGS computers
8. Appleworks software

NOTE: It is important that students understand basic instructions in how to manipulate the statistics and draw the graphs. To this end two important factors should be noted.
1. Close attention must be paid when basic instruction in the use of the Excel program are given.
2. To facilitate as even a distribution as possible of individual help to students, each student will be given chits which may be redeemed by individual help from the teacher. Students who need more help than others may ask students who need less help for their chits.

C. General Information

No knowledge of computers or programming is required. Typing skill is an asset, but not necessary. The computer programs are easy to use, versatile, and impressively powerful!

Basic instruction in their use will be given, and extra help will be available. The computers will do the "dirty work" quickly and accurately for you. You will be left free to test and analyze your social studies ideas. With some time and a little work, you will be able to achieve truly impressive results.

Computer piracy and games are strictly prohibited and will prosecuted (persecuted even) vigorously.

D. Procedures

1. Identify relationships to be tested.
2. Decide which data to use
3. Decide which kind(s) of graph(s) to use.
4. Manipulate data on spreadsheets to set up for graphs.
5. Construct graphs and get printouts of those which are appropriate.
6. Write a report to accompany the graphs, explaining what relationships

you tested, what
kinds of graphs you chose and why you chose them. Interpret and explain your findings.

E. Time (tentative)

Six hours of class time on Macintoshes, plus optional time in the tutorial period, noons, and after school in the Maclab or on the IIGS computers in the bookloft. (Work on graphs and spreadsheets must be done on the Macintoshes. Reports may be written up on either the Macintoshes [MS Works], or on the IIGSs [Appleworks].)

F. Information Available

(This information has been taken from the book and entered onto a spreadsheet on the computer for you.)

1. Countries

Algeria
Brazil
Canada
Colombia
Czechoslovakia
East Germany
Ecuador
Egypt
France
Guatemala
India
Indonesia
Iran
Israel
Jamaica
Japan
Kenya
New
Zealand
Pakistan
Peru
Philippines
Portugal
South Africa
Sudan
Tanzania
Thailand
Tunisia
UK
USA
USSR
Venezuela
Zaire
Zambia

2. Data

Population density, People/km^2
Birth rate, birth/1000 people/y
Death rate, deaths/1000 people/y
Life expectancy, y
Av. daily food intake, kJ/person/d
Av. daily protein intake, g/person/d
Electricity production, kW-h/person/y
Manufactured output, US$/person/y
GNP, US$/person/y
Literacy rate, % of total population
Energy consumption, kg/person/y
Primary activity, % of labour force
Secondary activity, % of labour force
Tertiary activity, % of labour force

3. Kinds of Graphs

Area
Bar
Column
Line
Scatter
Combination (various)

G. Data Manipulation Possible

-select two or three kinds of data available (eliminate the rest from the spreadsheet)
-rank countries and data according to one variable if you whish
-save your own, customized worksheet **under its own name. DON'T OVERWRITE i.e. Destroy the master worksheet!**
-get a printout of your worksheet if desired
-construct test graphs on your computer and pick the one(s) that best suit(s) your purposes.
-label your graph
-print your graph, then work on your written report.

H. Written Reports

Reports may be written longhand (single spaced) or typed (double spaced) if you wish, or:

Reports may be done on either Microsoft Works™ or Appleworks™ ("double" spaced) Spelling dictionaries and good quality, high speed printers are available in the Maclab and the bookloft. There are enough Macintoshes for each student to have his/her own.
The Maclab is networked, allowing each student to have memory space on the hard disc local area network. Those wishing to save their work to private floppy discs must provide their own discs.

Appendix 2: Statistical Table

note: this table is saved separately as an Excel document, and must be inserted manually. This page is included only to facilitate page numbering.

Don't forget to update bibliography!

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