DOCTOR OF PHILOSOPHY

The purpose of microcomputers in primary education.

Bullock, Alison Deborah

Award date:
1988

Awarding institution:
Bangor University

The

Purpose Of Microcomputers

In

Primary Education.

Thesis submitted as the full requirement for
the degree philosophiae doctor (Ph.D.).

School of Education,
University College of North Wales.
September 1988.

Alison Deborah Bullock.

ACKNOWLEDGEMENTS.

Principally, my thanks go to Wilf Carr for his continued supervision, support and inspiration. I am also grateful to Colin Baker who, together with Wilf, helped protect me from my own deficiencies. Thanks are also due to Colin Terry for his encouragement.

The University's three year studentship grant to support this work was much appreciated, as were facilities provided in the School of Education, for which I thank Prof. Iolo Williams. I was also grateful for funds from the Stanley Hewett Memorial Fund and the St. Mary's College Trust.

I should like to acknowledge the Director of Education for the permission to research in primary schools in Gwynedd, and Dafydd Roberts for his advice on the selection of schools. I also wish to record my appreciation of the friendly co-operation of the teachers and pupils I encountered in all the schools I visited. I am especially indebted to Tony and Merfyn for their time and their candour.

My thanks go to Anita and Spencer for their word processing skills. And Martin, for understanding.

TABLE OF CONTENTS.

LIST OF ABBREVIATIONS.

B.A.S.I.C.	Beginners All-purpose Symbolic Instruction Code
B.B.C.	British Broadcasting Corporation
C.A.L.	Computer Assisted Learning
C.E.T.	Council for Educational Technology
D.E.S.	Department of Education and Science
D.T.I.	Department of Trade and Industry
H.M.I.	Her Majesty's Inspectorate
H.M.S.O.	Her Majesty's Stationary Office
I.T.	Information Technology
I.T.M.A.	Investigations into Teaching with Microcomputers as an Aid
L.E.A.	Local Education Authority
M.A.P.E.	Microcomputers And Primary Education
M.E.P.	Microelectronics Education Programme
M.E.S.U.	Microelectronics Education Support Unit
M.E.U. (Cymru)	Microelectronics Education Unit (Wales)
M.I.T.	Masschusetts Institute of Technology
M.U.S.E.	Microcomputer Users in Secondary Education
N.D.P.C.A.L.	National Development Programme in Computer Assisted Learning
P.L.A.T.O.	Programmed Learning for Automatic Teaching Operations
P.L.E.T.	Programmed Learning and Educational Technology
S.P.S.S.	Statistical Package for the Social Sciences
T.E.S.	the Times Educational Supplement

REFERENCING SYSTEM.

The Harvard method of referencing is employed in this thesis: author is given, followed by date of publication. For example: Keeling (1988) reports that.....

When quoting, the author, date and page number are given.

A bibliography appears at the back and provides the following:-
(for books) author, date of publication, title of book, publisher and place of publication;
(for journals) author, date of publication, title of article, journal, volume and page numbers.

In the Notes section at the end of some chapters certain points in the thesis are expanded. This is indicated in the text by a number in "squiggley" brackets, for example, {1}.

ABSTRACT.

This thesis examines, conceptually and empirically, the educational role of microcomputers in primary schools. The first part of the thesis is, in the main, theoretical. It is concerned with making more explicit the meaning of the term "computer education" and the kinds of activities to which it may legitimately refer. The first chapters seek to substantiate the argument that, in essence, "computer education" is an attempt to use computers in ways which foster and promote the quality of the educational processes provided by schools.

Having considered computer education from a theoretical perspective, it is then explored empirically. An interpretive research methodology was utilized. The methods used to gather data were thus mostly qualitative, rather than quantitative. Case studies were undertaken to illuminate the ways in which computer education was interpreted in three primary schools. Attention focused on the educational values implicit in policy and practice and on identifying correspondence and discrepency between how computers were used and the educational philosophies espoused by individual teachers and schools. The empirical research revealed that imprecise, non-explicit and largely unarticulated intentions were being pursued by teachers in their employment of computers. No particular educational rationale was being explicitly adopted, even though, some close affinity between educational values and classroom practice would seem to be essential if the notion of "computer education" is to have any real meaning.

However, the conclusion of this thesis is not to doubt the importance of microcomputers in primary education. Rather, it is to suggest that fundamental questions about the educational purpose of computers need to be more rigorously addressed if computers are to be integrated into the curriculum of the future in ways which hold out some promise of improving the quality of educational experiences offered by primary schools.

PART ONE:

COMPUTER EDUCATION: CONCEPTUAL CONSIDERATIONS.

Chapter One: "COMPUTER EDUCATION": INTERPRETATIONS FROM THE LITERATURE.

1.1 Introduction.

Virtually all schools have a microcomputer: what has its introduction meant for the curriculum, the teacher and the pupils? What *is* "computer education"? A study of the literature makes it apparent that there is no consensus of opinion about what "computer education" actually means. Consulting the literature for an answer to a question like, "how should computers be used in schools?" is likely to result in disappointment and confusion. There really seems to be no clear answer to this question, and others like it. "Computer education", like Joseph's coat, appears to be of many colours.

This thesis addresses the question of the rationale behind "computer education". One of its main purposes is the clarification of such questions and the articulation of some tentative answers. Having clarified the issues, the way in which computers are used in primary schools today is then explored and assessed. Thus, the thesis is both analytical and empirical: analytical in the sense that it incorporates a sustained effort to clarify the meaning of computer education; empirical in the sense that it includes a study of classroom computer use. Questions of the type, "how should computers be used in schools?" first need to be explored analytically and hence, philosophically. Empirical investigation can then be used to reveal the extent to which the interpretation of "computer education" gained from the analytical work is actually being fostered and promoted in present day primary schools.

The empirical research of this thesis is not focused on some large scale survey of computer use in primary education: it is not merely concerned to describe what is currently happening in primary schools. Rather, it is concerned with assessing the extent to which what is happening conforms to what ought to be happening. Thus, the thesis does not just address the practice of computer education, or just its theory. Its focus is the point where theory and practice meet.

1.2 The First Problem.

From the literature, it is apparent that there are no clear answers to questions relating to what "computer education" should involve. One of the obvious reasons for this state of affairs is that the computer does not merely perform some single function or role: its uses are many and varied. Within education, the value of the computer entirely depends upon the way in which it is used, and who is using it. The computer can be used for anything from "drill-and-practice" instructional programs, to the creation of an environment in which children can, for instance, explore geometrical concepts. The literature offers plenty of advice about what "computer education" should be all about, but as often as not, this advice is in conflict, a point which Mc.gee (1984) recognizes in his complaint about the "amazing" lack of a visible coherent policy for computer education.

One obvious way to examine the term "computer education" is to look at the reasons why schools have been provided with microcomputers. How is the expenditure justified? The literature suggests motives for such an investment.

1.3 Preparing For A Computer-Based Society.

Schools have often explained the introduction of computers by claiming that pupils will need to be prepared for a computer-based society. For example, the Independent Schools Microelectronics Centre (1985) states:-

> "The main reason for introducing computers into schools is to prepare all pupils for the inevitable contact they will have with them both in and out of school later in their lives." (p2).

And the Microelectronics Education Programme (M.E.P.) was set up to help schools with this task:-

> "The aim of the Programme is to help schools prepare children for a life in a society in which devices and systems based on microelectronics are commonplace and pervasive."
> (M.E.P. Information Leaflet, Oct. 1984.)

This aim of the M.E.P. implies both that the microelectronics technology will create pervasive changes in society, and that "computer education" is all about preparing pupils for a computer-based society. Further, such statements assume that it is the schools' task to so prepare children. Associated with such implications is the idea that schools should imitate "life" outside school. Yet, as Peters (1967) has pointed out, this distinction between what goes on in classrooms and outside them (industry, politics, agriculture, rearing a family) is a false one. For, what goes on in classrooms:-

> "can and should spill over into things that go on outside, and transform them.... As a result of them, what is called 'life' develops different dimensions." (p8).

Also, it could be said that rather than preparing pupils for the world outside, schools should encourage pupils to question and change society.

Quite clearly, these assumptions and implications can be questioned. The M.E.P. may hold such views, but how do the schools themselves see the place of the microcomputer? Preparing pupils for a computer-based society is just one possible reason for its introduction.

1.4 The Roles Of The Microcomputer In Education.

Having purchased a microcomputer, its educational role may be regarded in many other ways. Sheingold et al (1983), in their survey of schools' and teachers' attitudes to the computer, discovered that most schools and teachers see a variety of purposes to which the microcomputer might be put. These include:-

-enhancing basic skills - drill-and-practice;
-an object of study - programming and computer literacy;
-a mode for delivering the curriculum;
-a resource for the teacher to use when appropriate;
-a reward for completed work;
-enhancing logical thinking and problem solving;
-enhancing motivation;
-adding fun to learning;
-helping children become comfortable with the technology;
-a learning environment for investigation;
-enriching the existing curriculum;
-introducing new areas of learning (word processing, data manipulation).

Thus, for teachers and schools, the microcomputer is considered valuable for many different reasons. Are all, or any of these reasons for using the microcomputer in school, educational reasons? Several writers have pointed out that the actual ways in which computers are being used in schools have been initiated by less than educational considerations:-

> "Most of the initiatives and funding programmes for the development of educational computing during the past 15 years has been prompted by political and technological considerations, and only subsequently justified in educational terms...."
> (Rushby, N., 1985, p27)

Other commentators too (Kelly, 1984) have recognized that this is partially a consequence of the fact that the major initiative behind the development of computer use in schools came from the Department of Trade and Industry rather than the Department of Education and Science. And this might have important implications since the D.T.I. and the D.E.S. have quite different underlying philosophies. As a result, Kelly (1984) suggests that attention might be deflected:-

> "from education to instruction, from Humanities to the Sciences, from the liberal to the vocational, from the worthwhile to the utilitarian...." (p163).

This indeed is a strong claim, but it is vital to examine the rationale behind the development and use of the computer in education. The term "computer education" may be, and is being, interpreted in different ways. And it is likely that different interpretations will have different implications and will be justified on different grounds. But what are these interpretations? How is the term "computer education" currently being understood?

1.5 Learning About The Computer.

To some, "computer education" means "learning about the computer". Computers in schools are objects of study. Such study may fall under a number of headings: "Computer Awareness", "Computer Appreciation", "Computer Studies", "Computer Literacy", "Information Technology". Unfortunately, these titles are not clearly defined and may mean different things to different people.

1.5.1 Meaning Of Terms: "Computer Awareness" And "Computer Literacy".

Most frequently debated is the difference in meaning between "Computer Awareness" and "Computer Literacy". In earlier writings, "Computer Literacy" seemed to be something of a blanket term. Under its heading, children might have gained knowledge about how computers work, how they are used and their effects on society, as well as knowledge of programming. More recently however, the term "Computer Literacy" has been distinguished from "Computer Awareness". For example, Watt's, (1982) concept of "Computer Literacy":-

> "...goes beyond its common definition as a body of information primarily about computers... That... should more appropriately be termed 'computer awareness'... I think of computer literacy as a cultural phenomenon which includes the full range of skills, of knowledge, and understanding, values and relationships necessary to function effectively and comfortably as a citizen of a computer-based society." (p56).

Even if it is established that, for some, the production of the computer literate pupil should be an objective of the curriculum, it is still not clear what the children should actually learn. Wilkinson (1983) asks:-

> "What kind of computer literacy do we want students to attain...? Definitions of computer literacy vary greatly. Some argue forcefully for teaching children, even very young ones, to program computers..., others argue, with equal force, that universal literacy in programming is unnecessary and may be infeasible." (p4).

Thus, "to program or not to program?" is one of the prominent questions raised in the debate. As far as the Independent Schools Microelectronics Centre is concerned, programming is not an essential feature of "computer education":-

> "....all pupils should appreciate both the power and limitations of the computer and recognise its implications for society. The object is certainly not to turn them all into computer programmers." (p2/3).

On the other hand, Hoyle (1983) insists that:-

> "If computer literacy is a desirable aim for all pupils then practice in programming and operating will be at the centre of this." (p56)

Leaving that issue aside, some schools, particularly primary schools, do not profess to offer Computer Literacy courses as such. Rather than considering "computer education" as "learning about computers", they prefer a broader interpretation: "learning with computers".

1.6 Learning With Computers.

Those who favour "learning with computers" tend to prefer a cross-curricular approach where the use of the computer becomes part of the everyday activities of the classroom, rather than something to be timetabled into subject boundaries. For example, M.A.P.E. (Micros And Primary Education) states that it:-

> "....does not want to let 'microelectronics' become a subject within the Primary School curriculum, for we believe the new technology is so essential that it must be absorbed into the very fabric of Primary/Middle School Education.... We also abhor its being locked only into mathematics and science - its use must be developed across the curriculum, and as a thinking tool." (Jones, R., March 1982, p5.6).

There are others too (Lewis, 1982) who stress that the computer should be seen as a tool; a resource to be utilized by teachers in their efforts to encourage pupils to learn, rather than an object of study. Writers (McGee, 1984; M.E.P., 1984) speak of the computer enlivening, enriching and extending the educational experiences offered to children; of the computer adding vitality and excitment to the learning. Generally, it seems to be accepted that the computer has a lot to offer schools, that potentially it has great educational value, but it remains unclear about the ways in which the computer, as a learning device, should be used in order to tap its great potential.

"Learning with the micro" covers a vast multitude of possible computer applications. What does "learning with the micro" mean? As already established, within an educational setting the computer can take on a number of roles. For example, it may act as a textbook, a teacher, a pupil, a partner, an examiner, a blackboard, an instructor, an exerciser, a laboratory or a demonstrator. Which role(s) should be adopted?

1.6.1 **Advice From The Literature.**

When the literature is examined for information about the way in which the computer can act as an aid to learning (rather than an object of study), a myriad of advice is found. Some commentators see the role of the computer as a resource that should be an integral part of the school. Haydon (1984) considers that:-

> "It is not desirable to treat the micro as anything other than a resource to be used as and when appropriate within the learning environment which a school seeks to establish... It is merely a tool..." (p3).

And Wilkinson (1983) recommends that:-

> "Like any tool, the computer should be available when needed but otherwise should be in the background..." (p11).

As for some kind of justification for its introduction, Peake (1984) says quite simply that:-

> "The computer is part of our world and as such should integrate fully into the curriculum as part of what we are doing." (p13).

The computer may be part of our world, and it may also be exciting and motivating but is this sufficient justification for its introduction? Sheard (1982) warns:-

"The justification of novelty and higher motivation must not be excuses for programs which do nothing that a teacher, a blackboard, a book or a worksheet could do as well if not better."

And continues:

"Not all C.A.L. (Computer Assisted Learning) programs will be new and exciting, but at least let us not use computers to perpetuate bad teaching techniques." (p5.35).

Finzer and Resek (1984) are in agreement:-

"Too much of what schools do with computers now is either focused on studying the computers themselves... or could be done as well or even better without the computer." (p58).

Children can learn with a computer in a number of ways, and it would seem fair to suggest that some of its uses are potentially more educationally valuable than others. The introduction of the computer does not automatically improve educational provision. For instance, some writers are critical of the way the computer is sometimes used solely for instructional, drill-and-practice purposes:-

"If the machines... are only to be used to support practice work in the 'basics' then it is very difficult to justify their purchase. The curriculum possibilities are far wider than drill and practice." (Garland, R., 1983, p79).

But, Wilkinson (1983) has pointed out that those who design software often see computers as:-

"valuable primarily for drill and classroom management, a way to occupy students with 'individualized instruction'". (p202).

Papert (1980) is critical of such employment of the computer (though recognizes its prevalence): he sees this as the computer programming the child:-

"In most contemporary educational situations where children come into contact with computers the computer is used to put the children through their paces, to provide exercises of an appropriate level of difficulty, to provide feedback, and to dispense information. The computer programming the child." (p19).

But there are alternative ways to utilize the micro; Papert continues:-

> "In the Logo environment the situation is reversed: the child, even at pre-school ages, is in control: The child programs the computer." (p19).

Others recognize and recommend other uses:-

> "The retrieval and manipulation of data is the essential facility of the computer... We need to encourage children to use the computer and databases for project work and learn how to use the information they gain." (Fothergill, R., 1982, p12).

It is clear that, within the educational setting, the computer can take on a number of roles, and that there is no established agreement about the way in which the computer <u>should</u> be used in schools. Indeed, uses are so diverse that the literature reveals several attempts to classify the roles of the micro in the school setting.

1.6.2 Classification Of Uses.

Taylor (1980) suggests three modes for understanding the application of the computer in education:-

> "In the first, the computer functions as a tutor. In the second, the computer functions as a tool. In the third, the computer functions as a tutee or student." (p2).

Briefly, Taylor explains that the computer in the role of a tutor presents subject material to which the student responds; the computer evaluates the response and as a result, determines what to present next. Functioning as a tool, the micro needs to have some useful capability programmed into it such as statistical analysis or word processing. And as a tutee, the computer allows itself to be tutored. To do this the learner needs to be able to program. It is not the place here to examine the relative merits of such computer roles. This will be tackled in later chapters. At the moment, the concern is with attempts to classify computer use in schools.

There is no universal agreement with Taylor's classification of computer use. A number of writers appear to apply the word "tool" almost as a blanket term covering most uses of the computer, including using the micro as a tutor and tutee. A much clearer classification has been developed by Kemmis and colleagues (1977):-

> "...we propose... three paradigms of education through which we may grasp the major ways in which the developers of computer assisted learning conceive the curriculum task. We have called these paradigms the 'instructional', the 'revelatory', and the 'conjectoral'." (p24).

To explain briefly, within the Instructional paradigm the computer acts as a patient tutor presenting drill-and-practice lessons; in the Revelatory paradigm, the computer presents a simulation of a real world situation; and within the Conjectoral paradigm, the computer is used to help the pupil formulate and test his/her hypotheses. Kemmis et al also suggest a fourth paradigm which they term the "emancipatory" paradigm. In this case the computer is used to reduce "inauthentic labour". These paradigms will be examined in greater detail in Chapter Two. They are referred to here simply to reinforce the point that computer use can be, and is, classified in a variety of ways.

1.7 Changes And Implications.

Writers tend to agree that the micro has "educational potential" and some are aware that its introduction could create important changes, and powerfully affect schooling as it is known today: the M.E.P. (1984) comments:-

> "The micro in the primary schools may be treated as an additional feature of the curriculum: it may, on the other hand, be an agent of fundamental change." (p6).

Contemplating the extent of this "fundamental change", Rushby (1985) thinks that the micro could be a major influence on the way in which we teach and learn. The M.E.P. (1984) indicates more specific areas where computer use in primary schools is likely to have important consequences, namely, curriculum content, the sequence of learning, the rate of learning and the way in which learning takes place. And if these changes do occur, what might be the consequences? Megarry (1983) believes that computers will profoundly affect what is taught, which could lead to:-

> "...different skills and perhaps a new role for the teaching profession. In the longer term the microelectronics revolution places a question mark over the very existence of schools and colleges as educational institutions." (p20).

Thinking along similar lines, Papert (1980) conjectures that:-

> "The computer presence will enable us to so modify the learning environment outside the classrooms that much if not all the knowledge schools presently try to teach with such pain and expense and such limited success will be learned, as the child learns to talk, painlessly, successfully, and without organised instruction. This obviously implies that schools as we know them today will have no place in the future." (p9).

Some writers, clearly, rate highly the power of the computer to affect education. Are their predictions acceptable? More needs to be uncovered about computer education before reasoned assessment of how micros might affect education may be made.

1.8 Issues Arising From The Literature.

The literature is conspicuously lacking in attempts to formulate a well grounded account of the educational value of computers, and the various consequences they may have on our understanding of education itself. Of the few attempts that have been made, no established positions have emerged. The meaning of the term "computer education" is diverse and there is no clear consensus of opinion about what "computer education" should concern. Which uses of the computer may be bracketed under the heading "education", and why? Are computers being used in schools in ways that have dubious educational validity? Is what is going on under the title "computer education" improving the quality of the educational provision made by schools? If there is "improvement", is it merely improvement in the instrumental efficiency with which existing curriculum objectives are pursued, or is it improvement to the educational quality of the processes themselves? What are the effects of computer use on our concept of education, on teachers, and on the nature of learning. Does the computer affect what is learnt or the way in which it is learnt? Will the computer change the curriculum and indeed the purpose of schools?

In order to answer these questions, criteria (in terms of which different attitudes and approaches to computer education can be identified and assessed), need to be established. Clearly such criteria cannot simply be distilled from a survey of the computer education literature. They can only be established by first forming some coherent criteria for determining the _educational_ value and validity of any policy or practice. Once these criteria have been established, it may then be possible to distinguish those uses of the computer which are "educational" from those which are not. They may also assist in the critical assessment of developments in computer education that are (or are not) educationally desirable. It is with the articulation of these criteria that Chapter Two is concerned.

Chapter Two: EDUCATIONAL THEORY AND COMPUTER PRACTICE.

It is clear from the examination of the literature in Chapter One that there is no agreement concerning the meaning of the term "computer education", and that uses of the computer are many and varied. It seems equally clear that "computer education" lacks what might be called a theory of computer education, that is, a substantial theoretical rationale which could clarify its meaning, justify its educational purpose and provide guidelines for its future development. The question, "can computers improve the quality of the educational processes offered by schools?" is of key importance in an examination of the purpose of microcomputers in education. In raising this question, it should be made clear that the computer cannot be abstracted from other factors that can contribute to the computer's effect on educational processes, (such as the quality of the teachers, the type of pupils or the ethos of the school) and that the computer's effect can be not only positive, but also negative, or indeed neutral. This important question may be restated as: "under what circumstances can computers improve the quality of the educational processes offered by schools?". Yet this question is still not as staight-forward as it might at first appear. It raises many other questions which demand examination before it can be fully understood: what does "quality" mean? How can it be assessed? What is meant by "educational processes"? How can it be recognized when the computer is being used for a distinctively educational purpose, rather than for some other purpose? Before it can be seen whether or not the computer is contributing to an improvement of the school's provision, it must be clear both what "educational provision" means, and what would constitute its improvement. Clearly, since there exist different ideas about what "education" means, there are also different ideas about what would constitute an improvement to its quality. Additionally, the computer does not merely perform some single function or role, and, it is anticipated that the way in which it is chosen to be used (or whether it is used at all), will depend on what is thought to be educationally valuable. There are, for example, significant differences in the educational philosophies underpinning the use of the computer for Papert's Logo (examined in detail in Chapter Seven) and the use of the computer for instructional learning. Howe and du Boulay (1979) comment:-

> "The diversity of educational roles reflects the computer's ability to do a wide variety of tasks, as well as different educational philosophies." (p241).

And each philosophy will have different implications for the learner, the teaching methods and the role of the teacher, and the curriculum. Howe and du Boulay continue:-

> "Each program can be located on a dimension anchored at one end by the view that students 'learn by being told', and at the other end by the view that they 'learn through discovery'. The teaching methods associated with the former method promote 'instructional' learning to satisfy the teaching objective of achieving a high level of performance in certain relatively limited functional skills. In contrast, those associated with the latter view promote 'relational' learning to satisfy the teaching objective of getting the learner to build relationships between new and old knowledge, making him better equipped to handle varying tasks." (p241).

This point is reiterated by Sheingold, Kane and Endreweit (1983) who recognise the different implications computer use can have for the learner:-

"Computer-assisted instruction... puts the learner in a relatively passive stance vis-a-vis the computer and emphasizes drill and practice. In contrast, new approaches emphasize placing the learner in an active role. Giving the child the initiative, enabling the child to take control and become the actual computer programmer, is thought to facilitate powerful learning in many domains." (p413).

To claim that the computer is being used for educational purposes assumes some background conception of what education is and what it is not. Thus, decisions regarding the use of computers in school are inevitably based on some idea of what education is all about and on how children learn: policies and decisions about computer education are policies and decisions about education itself, its purposes and aims. Cuffaro (1984) comments:-

"The discussion of micros in education has become an arena in which one can learn a great deal about education itself. In explaining, describing, hypothesizing and questioning what computers can and will do in education, statements are also made, implicitly or explicitly about the purpose of education, teaching, the content of the curriculum, and the nature of the learner." (p53).

This second chapter seeks to undermine the view that computer education can be treated in isolation from other more fundamental questions about the nature of education. Failing to see the mutual inter-dependence (between computer education and education itself) is an error, and one which is made by many writing about "computer education", as a look at the literature reveals. Treating computer education in isolation distorts the nature of the problem. A first step towards an understanding of the question "under what circumstances can computers improve the quality of educational processes?" is an examination of the concept of education itself.

2.1 The Concept Of Education.

What can be said of the question, "what is education?". What does it mean to call some process "education" rather than training, instruction, conditioning or even indoctrination? Should the term "education" be used to refer to a process of military training for instance? Does "education" refer to all that takes place in school? If not, what should be excluded?

An analysis of the literature of the philosophy of education reveals attempts to grapple with such questions. Many writers have gone to great length to explicate the concept of education, and two things are clear: one is that it is a very difficult question to tackle; the second is that those who have studied this question have come up with some very different responses. This is important since the view of education that is supported will have implications for practice. And the different conceptions of education will likewise have different implications for computer education.

2.1.1 Education: Not Merely A Descriptive Concept.

Looking at these points in more detail, "education" is more than a descriptive concept as the following illustration should make clear. Suppose an activity is merely described as follows: a child, ten years of age is copying a piece of writing from a book. How can the question "is this an educational activity?" be assessed? It is first necessary to discover the intention or purpose of the activity: is it a quote for part of an essay? is it a handwriting exercise? is it simply an activity to keep the child occupied? There could be a number of intentions behind the activity. It is only when the reason behind the task has been established that the activity may be judged to be "educational" or not. But what of this judgement? If it were to be ascertained that the reason for the exercise is the improvement of handwriting, then, for one who values neatness of handwriting the activity may well be judged to be educationally worthwhile. But, for some other person who, for instance, values the content/originality/creativity of writing rather than presentation, the activity may be thought of as "uneducational". The point is that such judgements are ultimately dependent on values. There is no agreed definition of "education" because there is no agreement about what kind of learning is valuable.

Frankena (1973) identifies two interpretations of "education". The first of these he describes as the "social science concept of education". This interpretation basically equates education with the process of socialization. Education is seen as a process which society employs to initiate its youth into its own prevailing values. As Frankena states:-

> "education is the process by which the individual acquires the many physical and social capacities demanded of him by society." (p19).

This social science concept of education, he considers, is purely descriptive. However, the other concept of education he identifies also embodies some idea of what ought to be done:-

> "'most educators' think of education 'in a way that [contains] value-judgements about what ought to go on in education' or about the sort of result education should produce." (p19-20).

This kind of concept is "normative" and, in suggesting it, Frankena is in agreement with Peters whose analysis of the concept of education is examined in some detail later in this chapter.

So, Frankena postulates that there are two interpretations of the concept of education, namely the descriptive, "social science" interpretation and the "normative" interpretation. The former, he explains:-

> "defines education as the transmission to the young of the dispositions or states of mind (beliefs, knowledges, skills, habits, traits, 'values', etc.) that are <u>regarded</u> as desirable by their elders..." (p20).

Whereas the latter defines education as:-

> "the fostering in the young of the dispositions or states of mind that <u>are</u> desirable." (p20).

As a guide to judgements about the concept of education, Frankena presents a formula which, he argues, caters for <u>any</u> interpretation of "education". Put simply, education within this formula, is an activity in which X is fostering, or seeking to foster in Y some disposition D by method M. The variables in this formula can represent any persons (X and Y), dispositions (D) and methods (M), and so accomodate all the different beliefs about what education is. Frankena illustrates this by representing the "descriptive", and the "normative" concepts of education in this form. For the social science concept of education:-

> "X = the society or its representatives;
> Y = its younger members;
> D = the dispositions regarded as desirable by society;
> M = the methods regarded as satisfactory by society." (p21).

These variables for the normative concept of education become:-

> "X = those doing the educating, whoever they are;
> Y = those being educated;
> D = the dispositions it <u>is</u> desirable Y should have;
> M = the methods that <u>are</u> satisfactory." (p21).

The differences are subtle, yet crucial. For the "descriptive" concept, education is:-

"the fostering by the older members of society of the dispositions they regard as desirable in its younger members by methods they (the older members) regard as satisfactory." (p21).

Whereas the normative concept of education is:-

"the enterprise, or any enterprise, in which anyone fosters desirable dispositions in anyone by satisfactory methods." (p21).

The dispositions and methods in the "social science" understanding of the concept of education are dictated purely by the society, rather than necessarily being in themselves desirable (as in the normative understanding). Rightly, Frankena emphasizes that the central issue concerns the question "what dispositions are to be fostered?". For within the social science concept of education, the teaching and learning in, for example, schools in Nazi Germany were "educational" processes. Since, however, the normative concept stipulates that both the dispositions taught and the methods used to teach them must in themselves be desirable, schools in Nazi Germany may well be deemed "anti-educational". For Frankena, as for Peters, both the content and method of education, understood in a normative sense, must be morally unobjectional.

After analysing in some detail both these interpretations of education, Frankena decides to reject the social science concept on a number of grounds: as well as placing those being educated in a passive role and leaving little space for experiment and science in determining what methods to use, it encourages a conformist attitude:-

"it limits education to the cultivation of methods and dispositions already regarded by society as satisfactory and desirable." (p23).

This, Frankena considers, makes the descriptive concept of education too narrow. Having adopted the normative concept of education, it then has to be asked, "which dispositions are desirable?", and "which methods are satisfactory?". But these are not questions to which straight-forward answers may be given. Frankena first points out that they:-

> "cannot be answered simply by asking what dispositions and methods are regarded as desirable or satisfactory by our society or by those being educated." (p27).

The question, "what dispositions are desirable and why are they desirable?" is a difficult and more important question than "what dispositions are desired - by society, by those doing the educating, or by those being educated?".

Frankena once again wants to draw attention to the common confusion between what is desirable and what is desired or regarded as desirable. Something may be regarded as desirable but not in itself be desirable. For example, the Nazi society thought it desirable to exterminate the Jews, but this in itself cannot be considered desirable. Frankena, like Peters and other educational philosophers, insists that educational dispositions and methods must be desirable/worthwhile/morally unobjectional in themselves. Accepting the normative concept of education means that no single answer to such questions can be given, because ultimately, what is considered to be a desirable outcome or satisfactory method is debatable. Frankena raises the question, "who is to determine what dispositions are desirable and what methods satisfactory?". And he comments:-

> "I find this question particularly baffling. In a way, the answer is, 'Whoever asks the question what education should be like must find his own answer.' Everyman must in a sense be his own educational philosopher." (p28).

Thus, questions about the nature of education are ultimately philosophical questions. Each person must decide for him/herself what outcomes or activities can be considered to be educationally desirable, and what methods of achieving these outcomes, educationally acceptable. This has obvious implications for how "computer education" is to be understood. The computer can be used in many ways, and the way in which it is chosen to be used, or the applications that are considered to be desirable and satisfactory, will depend on the sort of value judgements being made by those doing the educating. That "education" is a concept that necessarily implies values is a point that R. S. Peters has constantly made. Thus, he writes:-

> "Education is a concept that has a standard or norm, as it were, built into it. To speak of 'education', even in contexts quite remote from the classroom, is to commit oneself, by implication, to a judgement of value." (1959, p84)

And more recently, Daveney (1973) has made the same point in the following way:-

> "lying behind the concept of education is the notion of a norm or set of norms which gives the education its purpose." (p79).

Hence, claims Daveney, a system of education logically implies an ideal of mankind or society. Therefore, to understand a particular educational system it is necessary to understand the underlying views of mankind and society, the norms that give the education its purpose. So, in order to assess such a question as "is the microcomputer being used educationally?" the intentions or purposes of the teacher or program must first be established. For example, if the microcomputer was observed being used to administer a spelling test, before the extent to which this activity might be "educational" could be assessed, the purpose of the activity has first to be discovered. In this case the reason for the activity might be the improvement of the children's spelling ability (rather than perhaps part of a "familiarization with the technology" programme). It could then be considered to what extent this activity might be called "educational". Some might (mistakenly) assess it solely in its own terms, and consider whether using the computer in this way more effectively or efficiently improves the children's spelling ability, than if alternative, non-computer-based methods are used. In fact, here, the question, "did the computer improve the effectiveness/efficiency of the achievement of the existing "educational" goals?" is being considered. However, more interestingly, it might be asked whether the activity itself is an educational activity, and "to what extent was the computer being used to improve the educational quality of the goals themselves?" Responses to the latter questions will depend on what the concept of education means to the observer, a meaning which will itself depend on the set of values that is held.

R. S. Peters offers a useful analysis of the criteria which he believes are distinctive to "education", though of course, his argument is open to criticism (Woods & Barrow, 1975). However, an examination of his analysis should result in a better understanding of the question "what is education?", in preparation for assessing the purpose of microcomputers in education.

2.1.2 R. S. Peters' Analysis Of The Concept Of Education.

In his influential paper, "What Is An Educational Process?", Peters (1967) maps out what is meant by calling a process "educational" and in so doing, brings to light what he takes to be the criteria inherent in the concept of education itself. It is important now to examine Peters' account in the anticipation that it will lead to a greater understanding of the term "computer education".

For Peters, "education" is not a concept that is easily defined. It is not merely a descriptive concept: education is not a straightforward quality like being green or being heavy. Nor can it be simply recognised on sight - like laughter. It is possible to observe people taking part in a number of activities which may, or may not, be "educational" - for example, reading, travelling, conversation. So, Peters proclaims that:-

> "Education... refers to no particular process; rather it encapsulates criteria to which any one of a family of processes must conform." (p1).

Hence, teaching, training and instruction, as instances, may be called educational processes only if they satisfy these criteria. "Education" is like a "stamp of approval" (p2) proclaiming that the process has come up to certain standards. And these standards are an intrinsic feature of "education".

But what does the process of education lead up to or result in? Peters explains:-

> "Just as 'finding' is the achievement relative to 'looking', so 'being educated' is the achievement relative to a family of tasks which we call processes of education." (p2).

In other words, education is a concept that has an end built into it. Not only does calling someone "educated" imply change, it also implies that the change is for the better: the change is regarded as worthwhile: calling a person "educated" can only imply approval. It makes no sense to say things of the sort:- "he's a very pleasant man.... <u>except</u> he's educated". Being educated is seen as a virtue. Hence, just as with other virtues, (for example, being honest), being educated does not need to be justified on external grounds. Indeed, according to Peters, education by definition, is a desirable end in itself, rather than a means to some external end. It is not necessary to appeal to extrinsic benefits when justifying education (for example, "it's worth being educated because you'll gain respect...."). Education should not be regarded as a means for the production of gains; gains may result from the process of education but these are incidental, since education is of value in itself. As O'Hear (1981) comments:-

> "Peters considers it to be a crucial misunderstanding of education to think of it as a means to an end, even though extrinsic goals such as getting better jobs or socialization in some general sense might be achieved through the process of education." (p35).

What this means is that anyone who considers "computer education" simply as a means of producing computer programmers, for example, has seriously misunderstood the nature of education. Peters, for similar reasons, rejects the concept of vocational education, where this means "education for jobs". Education implies some worthwhile change for the better and is seen as an end in itself. In relation to this, to speak of somebody as "educated" implies success: this person has achieved the end inherent in the process, just as there is the implication of success in saying that someone has found what they were looking for. But, Peters also remarks that:-

> "I can work away at educating people, without the implication that I or they achieve success in the various tasks which are engaged in." (p2).

A person may be engaged in an educational process, but success is only implied if we speak of them as having achieved the end by calling them "educated".

To summarize then, Peters' first major point is that "education" refers to a family of processes which conform to certain criteria, and that success is implied in calling someone "educated", since "being educated" is an end in itself.

The second major point made by Peters is that education is "inseparable from judgements of value" (p3). Education concerns changes for the better, but what counts as worthwhile change depends on value judgements. More explicitly, two of the criteria inherent in the concept of education are that both the content and the method of the process(es) must be morally unobjectionable. For example, the process whereby children learn things by conditioning or indoctrination may not be said to be educational since these methods can be regarded as morally unjustifiable. So, Peters claims that:-

> "to say that we are educating people commits us... to morally legitimate procedures." (p3).

And likewise, what is learnt, the content, must be considered to be worthwhile. If this was not so, then such things as learning to steal, or even trivial pursuits, such as Bingo, could be considered to be "educational". What is learnt must be worthwhile or valuable. It makes no sense to say that this person has been educated but learnt nothing of value. To sum then, as Peters states:-

> "...if something is to count as 'educational' what is learnt must be regarded as worthwhile just as the manner in which it is learnt must be regarded as morally unobjectionable." (p4).

But these two criteria are of course tied up with value judgements. For it is necessary to decide for oneself whether or not the method is morally unobjectional, and the content worthwhile. It has been noted already that since education is not simply a descriptive concept, it is one that is dependent on values. This also seems to be in harmony with the idea that education is an essentially contestable concept (which shall be explored later); there is no established agreement about what content is to be considered worthwhile, and what methods morally unobjectionable. Peters, speaking of these two criteria, concludes:-

> "under this general aegis of desirability 'education' picks out no one type of task or achievement. People differ in their estimates of desirability. They therefore differ in the emphasis which they place on achievement and states of mind that can be thought of as desirable." (p5).

In a later paper (Hirst and Peters, 1970) he adds that :-

> "at least this general end would give criteria by reference to which decisions taken on educational grounds could be distinguished from decisions taken on personal, economic, or medical grounds." (p20).

Peters then goes on to expand the criteria that need to be satisfied if one is to call a person "educated". The first point he makes is that the educated person needs more than just know-how or knack. The person who has simply mastered a skill might not be thought of as educated, however worthwhile that skill may be. The educated person must also "know-that" certain things are the case:-

> "He must have developed some sort of conceptual scheme at least in the area in which he is skilled." (p6).

But, a merely well-informed person cannot be thought of as educated. This leads on to another criterion laid down by Peters:-

> "To be educated requires also some understanding of principles, of the 'reason why' of things." (p6).

Hence we might be reluctant to conclude that the Mastermind champion is educated on the basis of his/her performance at the quiz, since s/he has not had the opportunity to display understanding of his/her knowledge-that certain things are the case. And, understanding is important since,

> "failure to grasp underlying principles leads to unintelligent rule of thumb applications of rules, to the inability to make exceptions on relevant grounds and to bewilderment when confronted with novel situations." (p6).

The next criterion that Peters indicates concerns the issue of variety of knowledge and understanding. He raises the question, "could a man be educated whose knowledge and understanding is confined to one sphere?" (p7). Ruth Lawrence, the girl who recently gained a double first at Cambridge in Maths and Physics at a very young age, and who then went on to undertake study for a Ph.D. in the same area, immediately springs to mind. Full details of her studies are unknown, but on the basis of her reported activities, some would be wary of calling her educated in any full or proper sense. Peters would apparently agree since he says:-

> "There is a strong inclination to deny that we could call a man 'educated' who had only developed his awareness and understanding in such a limited way; for our notion of an educated man suggests a more all-round type of development." (p7).

And he uses this "all-round" criterion to draw a distinction between "education" and "training". He explains that "training" always suggests confinement - people are trained for specific activities, and it is not possible to train people in a general sort of way. But, he continues,

> "this lack of specificity is just what is suggested by 'education'." (p7).

The final criterion for the educated person that Peters indicates is that his/her knowledge and understanding must not be "inert". They must not be "inert" in the sense that:-

> "they make no difference to his general view of the world, his actions within it and reactions to it, or in the sense that they involve no concern for the standards imminent in forms of thought and awareness, as well as the ability to attain them." (p9).

This criterion is quite difficult to grasp. Basically what Peters is saying is that the educated person's knowledge and understanding must make a difference to him; they must affect his attitude to life, must not be sterile and inert. Peters explains by saying that:-

> "'education' implies that a man's outlook is transformed by what he knows." (p7) "....activities like history, literary appreciation, and philosophy, unlike Bingo and billiards, involve forms of thought and awareness that can and should spill over into things that go on outside and transform them." (p8).

In explaining the second sense in which the educated person's knowledge and understanding should not be "inert", Peters says that they must involve commitment. The educated person must care about the standards of appraisal inherent in all forms of thought and awareness. As Peters poignantly remarks:-

> "...to be educated is not to have arrived; it is to travel with a different view." (p8).

After examining the criteria involved in the concept of the "educated" person, (the achievement aspect of "education"), Peters continues by looking at the criteria inherent in the concept of an "educational" process, (the task aspect of "education").

Two initial points are made: firstly, an "educational" process must have intention - the teacher must intentionally try to get the learning process going along desirable lines; and secondly, processes may only be termed "educational" if the learner is conscious of what is going on - "educational" processes "must be ones in which he (the learner) knows what he is doing" (p9). If the learner is not conscious of the process, then it cannot be called "educational". The hypnotic process is perhaps one that is clearly not "educational". Peters states that:-

> "educational processes... are those in which people are initiated into or got going on activities and forms of thought and conduct which they eventually come to master... They must... approximate to tasks in which the learner knows what he is doing." (p9).

But it is not clear exactly what processes can belong to the family of "educational" processes. Educational processes <u>can</u> include such things as "training, instruction, learning by experience, teaching, and so on", (p9). However, "training" and "instruction" are not synonymous with "education". People do not speak of "educating" animals, rather, animals are "trained". Peters (and Hirst) later (1970) argues that a distinction must be made between educating people and training them because education is not compatible with any narrowly conceived enterprise. But there are other processes bordering on the educational which fail to satisfy the criteria. And it is these to which Peters' attention next turns. Peters first distinguishes "extrinsic aids" as being things which may create better learning situations (like providing a warm, dry working environment), but which are not themselves educational processes. These things are purely external to the learning, although may aid learning:-

> "....conditions such as praise and reward... help children to learn things. These are not processes of education; for their connection with what is learnt is purely extrinsic... Neither turning on the radiators nor smiling at children are educational processes, whatever their status as aids to education." (p10).

Next, Peters highlights the distinction between an educational process, and the process of "picking things up". Through-out life, a variety of things will be picked up, but even if this process provides people with worthwhile attitudes, (like respect for persons and open-mindedness), it cannot be called "educational". This is because it does not satisfy certain criteria. The process whereby things are picked up is not intentional. The teacher may not intentionally pass on, for instance, a passion for literature - the pupils may simply pick this up. And likewise, the pupils do not consciously pick up particular attitudes. Picking things up simply happens. It cannot be considered an achievement.

> "....'education' does suggest some kind of intentionality on the part of the learner." (p14).

Processes of "picking things up", and "aids" to education are not in themselves educational processes. So what may count as processes of education proper? Peters stipulates that these:-

> "can be viewed as a family of tasks leading up to the achievement of being educated...." which "involves mastery of some skills, knowledge, and understanding of principles." (p14).

These three components (skills, knowledge, and understanding), are looked at individually and the educational processes which are particularly relevant to each are considered.

To summarise these very briefly, firstly, mastery of skills necessarily involves practice, instruction, correction and example. And "the general name we have for this type of learning process is 'training'" (p15). "Training" does not place great emphasis on understanding.

The second component of being educated, acquiring a body of knowledge, requires instruction and explanation as well as first-hand experience. The educational process involving "instruction and learning by experience" (p16) is particularly relevant in this case.

The third, and most important component of being educated concerns the understanding of principles. And the most appropriate educational process for this is "teaching". Understanding requires reflection on what is already known. Peters proclaims that:-

"The typical term for the educational process by means of which people are brought to understand principles is 'teaching'; for 'teach unlike 'train' or 'instruct', suggests that a rationale is to be grasped behind the skill or body of knowledge." (p19).

Training and instruction can be part of an educational process, but on their own they are not educational processes because they are unable to satisfy all the criteria.

Peters illuminates a further point about the process of teaching, namely that:-

"the teacher is to pass on a body of knowledge in such a way that a critical attitude towards it can also develop." (p19).

In this way, the distinction between "teaching" and "indoctrination" is made clear:-

"for indoctrination is incompatible with the development of critical thought." (p19).

R. S. Peters' analysis of the concept of education is useful since it clarifies some important issues. He recognises the place of values in such an analysis, although he also lays down criteria to which any process must conform if it is to be labelled "educational". Such an awareness is clearly important when considering the circumstances under which the computer can be used to promote <u>educational</u> processes. An analysis of the concept of education may also assist in the recognition of situations where the computer is used for other than educational purposes. However, if Peters' analysis of the concept of education is accepted, then it is impossible to have any irrefutable replies to such questions as "what is education?". Not everyone will agree that activity X is "educational"; the criteria for an "educational" activity are always contestable; any judgement will be based on the values maintained by that person. Indeed, since the concept of education appears to be dependent on contested values, some writers have labelled it as an "essentially contested concept".

2.1.3 Education: An Essentially Contested Concept?

An essentially contested concept is one which is intrinsically debatable: a concept which can never be established as unquestionable. As Harnett and Naish (1976) explain:-

> "Essentially contested concepts have no clearly definable general use that is correct/standard." (p80).

Such a concept like education, they claim, has no correct definition. Further, if a concept is essentially contestable then reasonable men it is said, will not underestimate their opponents' opinions about how the concept is to be understood. This has a number of implications. If "education" is accepted as being an "essentially contestable" concept then the following points may be made:-

First, it is probable that there will exist more than one, justifiable definition of education:-

> "There is likely to be a number of competing views about the nature of education, and about what can count as an educational aim, and more than one of this number might be justified."
> (Harnett & Naish, 1976, p86)

Consequently, a number of views about what constitutes educational success or failure will exist, and therefore people might hold different views about their duties, responsibilities or rights as educators.

Secondly, it follows, from the previous point, that it is not justifiable to impose one fixed set of educational goals which all must adher to. Harnett and Naish (1976) recommend that the power and authority that might be used to encourage co-operative and concerted effort ought to be limited. In practice, they claim that this means that:-

> "schools within the educational system ought not necessarily all to share a common set of aims but rather that there should be a diversity of aims reflecting current contestant justifiable views of education." (p87).

Finally, if education is an essentially contested concept, it does not follow that <u>any</u> stipulation of what education is or should be, is permissible; nor does it follow that there is <u>nothing</u> distinctive about education. This is an important point since, by implication, it seems that it might be possible to lay down criteria to which the use of the word education should comply, as Peters has done, since <u>any</u> specification of what education is, will not do.

One of the implications of "education" being an essentially contested concept is that it is probable that there will exist more than one, justifiable view of education. Anyone who uses the term "education", to describe an activity, will use it according to certain criteria (often held implicitly), and these criteria will differ according to the particular conception of education being employed. Hence, the way in which the computer is chosen to be used will differ according to the different conceptions of education held. It might be fruitful to examine the dominant conceptions of education that have emerged and draw attention to the assumptions and implications they support.

2.2 Dominant Theories Of Education.

Peters has clearly analysed the concept of education. However, since it has been argued that education is an essentially contested concept, then one of the implications is that there are various different conceptions of education, not that some are "right" and some are "wrong", rather that there is no single meaning of the concept, and hence no single "theory". A word on the nature of educational theory might thus be a useful precursor to an examination of some of the dominant educational theories that have arisen.

2.2.1 The Nature Of Educational Theory.

There are a great number of different educational theories. For this reason, the educational theory expounded by, for instance, John Dewey is very different from that of Plato. However, educational theories do have common features (which have been outlined by Moore, 1974). One common feature is that they are more prescriptive than descriptive. Educational theories, unlike most scientific theories, are concerned with guiding practice, and are, in this sense, prescriptive; they are concerned with what ought to be done. Another common feature is that they all present some desirable end, which it is believed ought to be brought about, and certain procedures, which are recommended to bring this end about. As a result, a further common feature is that certain assumptions, about the ends to be achieved, about those who are to be educated and about the methods to be used in educating them, are necessarily involved in general{1} educational theories. Moore (1974) states:-

(1) "all general theories of education will start from assumptions in respect of aims to be achieved, which imply the making of a certain type of man." (p18).

(2) "a general theory of education will need to make some assumptions about children if it is to make any serious recommendations about how they should be taught and to what end." (p19).

(3) "any general educational theory will inevitably involve assumptions about what is to be learned and the most effective ways of learning and teaching it." (p20).

Since there are many educational theories, how can they be justified? To be justified, a theory must be open to testing. Some have found this a problem with educational theories, but Moore (1974) outlines a number of ways in which a general theory of education might be open to attack:-

> "A theory... could be faulted for lack of internal coherence. Or it might be shown that the assumptions themselves are faulty." (p22)

A justifiable, general (as opposed to limited) educational theory has to exhibit internal consistency and coherence in addition to sound assumptions. And a general educational theory is defensible if it can be shown that:-

> "its aims were capable of being realised and morally acceptable, that its assumptions about pupils were supported by appropriate evidence, and that no exception could be taken to its assumptions about the nature of knowledge and the appropriateness of methods. In other words the theory could be validated by showing it to be rationally defensible." (p25).

So, the structure of educational theory involves assumptions about the ends (the educated man), the learner, and about the content and method of what is to be learnt. And as has been pointed out already, and Moore (1974) reiterates:-

> "different assumptions will result in different theories with different recommendations for practice." (p26).

This can be illustrated now by outlining dominant theories of education. Different views about the "educated" person have resulted in two broad attitudes to education, often referred to as "Traditional" and

"Progressive", each embodying different assumptions about the end(s), or purposes, of education, the nature of the learner, and the content and method of the curriculum.

Since much educational practice tends to lean towards either the Traditional or the Progressive theory of education, the applications of the computer may be analysed more usefully if these dominant theories are considered in some detail first. This exercise should reveal the respective underlying assumptions and value judgements which will in turn illuminate the implications of using the computer in education. However, it must be emphasized that the terms "Traditional" and "Progressive" are only general labels. The labels are used merely to highlight consistent strands of thought about education: sub-theories within either of these broad categories may be more Traditional/Progressive, or less so, than others.

2.2.2 The Traditional View Of Education.

Traditionalists claim that the word "education" derives from the Latin infinitive "educare" which can be translated as "to train, bring up, or rear". Education is seen as a rearing process, the aim being to mould pupils into their appropriate roles in society. The "moulding" metaphor is sometimes employed where education is thought of as preparation for a given predicted future form of life. ("Educare" was also used in reference to animals and plants). Pupils are thought of as empty vessels to be filled by the teachers. In practice, academic work is emphasized and instructional methods most often used. The only ones thought to have succeeded in education are the minority who do well in academic work. And this mass-minority distinction is encouraged by a selective system of education, where the most academically bright are creamed-off and undergo a different process of education. A clearer idea of this theory may be gained from a consideration of the way in which a specific advocate of this view interprets "education".

Plato is often claimed to be the founder of the Traditional view of education. In "The Republic", he put forward his conception of the perfect State in which education played a key role. Plato reasoned that the intention of education is to fit people for their roles in society. This, he argued, could be brought about by a selective system of education: the rulers reach the peak of the pyramid of education, and through their learning, become "philosopher kings". Plato believed that there was no single innate nature indicative to mankind, rather that there were several kinds of innate natures, and that the aim of education was the adjustment of individuals to their own innate nature and their allocation to the most appropriate social/economic role. He spoke of the "appetitive", the "spiritual" and the "rational" natures, and believed that those natures were best suited to particular roles in society, namely the role of the worker (who satisfied the economic needs of the society), the soldier (who took care of society's military needs), and the ruler (who governed the society). Thus, his theory incorporates the mass-minority distinction - the selection of the academic minority for the "special" kind of education. Under Plato's system, the superior positions in society would be held by those who had the superior form of education. Indeed, the much more recent selective Tripartite system, in some respects, reflects Plato's Traditional theory of education.

This outline provides an idea of the Traditional view of education. Such a view endorses a particular view of knowledge and has implications for the role of the teacher, the learner and the curriculum.

2.2.2.1 **The Implied View Of Knowledge.**

The Traditional theory of education supports a "rationalist" (as opposed to "empiricist") view of the nature of knowledge. Knowledge, in this sense, is based on rationality or reason, rather than experience of the senses:-

> "....it accepts the validity of knowledge which is a priori, independent of any experience of the senses.
> (Kelly, A. V., 1986, p6).

Knowledge is thought of as certain and relatively unchanging. Emphasis is placed on "knowing-that" rather than "knowing-how", the former being believed to be superior. As a result, an academic curriculum is preferred, promoting intellectual rather than any other kinds of development. The curriculum is seen as a vehicle for knowledge transmission.

2.2.2.2 **Implications For The Curriculum.**

The Traditional theory supports a subject-based curriculum. The view embodies the idea that the curriculum should be arranged in subject areas which have rigid boundaries, and where the importance of the timetable is recognized. The curriculum varies according to the assessed abilities of the pupils - pupils are selected either for the more academic or more practical curriculum: there is often a division between mental and manual skills and knowledge. These implications are clearly reflected in many secondary school organizations. Although there is not such a clear reflection from primary school practice in general, the Traditional theory does imply a more formal curriculum arrangement which can be seen in some primary schools. Within the subject areas, emphasis is placed on the acquisition of knowledge and skills, and often the success of the learning is measured by regular tests. So, the Traditional theory of education would be reflected in a primary school whose curriculum, for example, divided the day into lessons of maths, English and Welsh in the mornings, and other clearly defined subjects in the afternoon; employed regular tests of the children's ability to memorize spellings or tables, for instance, and made a clear distinction between work and play.

The Traditional theory of education does not support an integrated curriculum (except, perhaps in the earliest days of schooling), rather, it implies a selective, streamed system and a subject-based curriculum.

2.2.2.3 **Implications For The Learner.**

Unlike the Progressive, who generally believes the learner to be inherently curious and interested, the Traditionalist tends to think of the learner as disinclined to education. A supporter of the Traditional view puts the learner in a very passive position: the learner is initially regarded as an empty vessel who, for the process of education, becomes a receiver of transmitted knowledge, over which s/he has little, or no, choice or control. Amongst the group of learners, there is usually an air of competitiveness rather than co-operation, though sometimes the pupils may work on individualized tasks. The learners are preferred to be obedient and hard-working, concentrating on the fixed task in hand.

2.2.2.4 **Implications For The Teacher.**

The teacher is seen as an authority within his/her subject area, who prefers strict boundaries between his/her own subject area and others, rather than any form of curriculum integration. The teacher's task is the selection, ordering and transmission of the knowledge within his/her field. Through methods of direction, compulsion and restraint, (Moore, 1974), the empty learner is filled with the received wisdom of the teacher. Instruction is a favoured method of teaching.

The relationship between teacher and learner is hierarchical: the pupils are required to accept the assumed authority and superiority of the teachers.

Up to this point, the outline of the Traditional theory of education has been descriptive and relatively uncritical. Perhaps now, some of the criticism voiced against the theory should be heard.

2.2.2.5. **Criticisms Of The Traditional View Of Education.**

Supporters of the Traditional view of education argue that the theory is a realistic one since the education system is seen as reflecting the principles of wider society. On this view, Kemmis, Cole and Suggett (1983) report that:-

> "schools recognise 'intelligence', select appropriately and prepare students efficiently to participate effectively in the society which awaits them beyond school." (p9).

But, without even entering into the debate about whether intelligence can be recognized, or measured, there are grounds for rejecting this view of education. Peters would say that fitting people for their role in society is merely socialization, and in Moore's terms, a "limited"{1} theory of education. Other critics are very unhappy about the social and political implications of the view. The Traditional theory encourages a mass-minority distinction which could have serious wider social implications. This ideology supports an anti-democratic, authoritarian and elitist society: the leaders are selected from the minority who have received the "best" education (see how the public school system supports the Traditional view).

One of the major faults of this view is the problem of selection in practice. How can this intelligence be recognized? Silbeck (1976) writes that although more scientific forms of selection have been adopted in the twentieth century, they are far from perfect, and:-

> "the evidence is overwhelming that social class remains a major determinant of the elite membership." (p26).

A class divided society is perpetuated by this view. The minority are chosen for a more superior form of education than the masses, by procedures of selection which are biased unfavourably towards the Working Class.

Others reject the Traditional teaching methods which they see as authoritarian and ignorant of the nature of the learner. Methods which cultivate an undesirable intellectual attitude are rejected. Undesirable methods are seen as those which encourage the pupil to be passive, docile, to be afraid of disagreeing, and as a result, to be uncreative and unoriginal. And it is argued that the same methods foster undesirable social attitudes - competition, self-interest, conformity, passive obedience. Skilbeck (1976) writes that the Traditional theory has been associated with:-

> "predefined views about what it is fitting to do, feel, think, and with standards of performance in all spheres. Education may be active but it is always primarily an assimilative process: induction into institutions; acceptance of defined values and standards...." (p28).

These are just some of the criticisms that have been levelled at the generally Traditional view of education. The Progressive theory of education represents the major alternative view, and attention is next turned to this.

2.2.3 The Progressive View Of Education.

Whereas the Traditionalists claim that the root of "education" is the Latin "educare", the Progressives believe its derivative is "educere". "Educere" can be taken to mean "to draw out" or "lead forth", and the general aim of education has been suggested as the development or realization of individual potentialities. The "growth" metaphor is associated with this theory; through education, individuals may grow towards self-fulfillment and self-realization. Unlike the Traditional view which sees the main concern of education as preparation for the future (and by so doing, assumes the future is unchanging, or at least predictable), the Progressive view sees education as equipping individuals with the ability to question and <u>make</u> the future, which cannot be forseen. One particular Progressive view (the social reconstructionalist) sees society as being restructured by each new generation and therefore does not value preparation for the status quo.

There exists more than one interpretation of the Progressive view of education: under this general label there are to be found different interpretations of Progressivism. But they are similar enough in their broad principles for them all to be called "Progressive". The differences arise from different emphasis placed on certain general principles of the Progressive theory. All the interpretations express dissatisfaction with the Traditional subject- and adult-centred view of education which neglects to consider the learner. Progressives value, above all else, the individual learner, and see education as instrinsically worthwhile rather than instrumental in any way.

For the purposes of this study, the interpretations of the

Progressive view will be divided into three less broad classifications, namely, the "Romantic", the "Social Reconstructionalist", and the "Liberal". Each shall be examined in turn.

2.2.3.1 **The Romantic View.**

Historically, Progressive ideas of education are said to have been influenced by, if not originated from, Rousseau, and the Romantic Movement in eighteenth century Europe. Rousseau, the author of "Emile" and a leader of the Romantic Movement, held the view that the concerns of the developing child should be discovered and followed: this, he recommended, should be the main focus of education rather than the transmission of a cultural heritage. Rousseau rejected violently the idea that children are material to be poured into the adult mould. As far as education is concerned, Rousseau believed that the child's natural curiosity would spur him/her on to the discovery of answers to the questions s/he had formulated. Thus, for Emile, as Skilbeck, (1976) writing about Rousseau, explains:-

> "it is not mathematics or language in any formal sense that the boy is taught, but mathematical understanding and linguistic skill are developed, by an artful and well-informed teacher, through the educational exploitation of the situations of everyday life." (p31).

A. S. Neill and his work at "Summerhill" (founded 1921) is a more recent example of this Romantic view. Neill believed in the natural innate goodness and wisdom of children. He claimed that if children were left to themselves, with no interference from adults, they would develop. He recommended that no attempt should be made to steer children towards any preconceived objectives. He saw happiness as the central aim in life, and said that if children were left to do as they wished, they would become happy and social people. So at his school, "Summerhill", children pursued their own interests: compulsory attendance at lessons was not demanded. Neill's ideas could be expanded in much greater detail, but unfortunately, it is not easy to recount his educational ideology as it lacks internal coherency and consistency. Suffice it to say that Neill can be regarded as one who holds the Romantic view of education.

The Romantics firmly believe in the natural goodness of children and the idea that children will develop educationally if they are largely left alone to follow their own devices. However, not all Progressives hold this extreme Romantic opinion.

2.2.3.2 **The Social Reconstructionalist View.**

The Social Reconstructionalists seek to improve present day society. They are critical of the status quo and desire basic cultural change. Skilbeck (1976), a modern Social Reconstructionalist, sees education as:-

> "a key process in lessening social conflict and in developing new patterns of life". (p36).

These theorists are particularly critical of the Traditional concept of education which encourages an accepting attitude in pupils, and in schooling which aims to fit children into society, rather than encourage the questioning of values in society itself. They believe the aim of education should be the development of critical thought and rationality. The scientific model is adopted for this purpose. The study of science and social science, they argue, should be emphasized for two reasons:-

> "First,.. the content of the sciences... reflects, incorporates, and expresses the modern world, especially its impetus for change and the concepts and methodologies necessary to organise and direct change... Second, the method of rational reflective inquiry, which for the reconstructionalists is basic to the whole education process, is derived from a loose generalized model of scientific thinking." (Skilbeck, 1976, p40).

The Social Reconstructionalists claim Dewey as one of their advocates since he recommended a science oriented progressivism. This emphasis reveals one of the differences between this view and the Romantic view. Cohen (1983), writing on Dewey, reports that he believed:-

> "a constructive problem-solving approach has to go beyond the stage of undifferentiated curiosity. The notion of discovery, then, needs to be strengthened and augmented by the focus on problem-solving." (p57).

For the Social Reconstructionalists, experience is very important, but they argue it should be ordered in such a way as to produce rationality. Dewey's scientific model of problem solving is thought to so organize experience. This model involves the following steps:-

(1) experience of a problem,
(2) information,
(3) formulation of an hypothesis,
(4) reasoning,
(5) testing, and on the result, a sixth stage might take the problem solver back to stage 3.

Hence, children should first be encouraged to centre their attention on a problem, then come up with some idea of its solution by seeking out appropriate information. The consequences of the possible solution would then be studied, which may result in rejection of the hypothesis and the formulation of a new one. Finally, the children would test the possible solution to discover if, in fact, it does succeed in solving the problem. Consequently, Dewey recommended that teaching methods should provide the pupil with the opportunity to solve his/her problems by direct first-hand experience, so developing problem solving techniques, and thus rationality.

Perhaps from this it might appear that science is the only concern of the Social Reconstructionalists, but Skilbeck (1976) points out that from an educational stand-point, what is important is not the production of scientific elites, rather science should be used for the deliberate cultivation of rationality, of problem solving procedures, adaptability and flexibility, and a generalized capacity to face up to the problems of practical life.

2.2.3.3 **The Liberal View.**

It is not at all easy to put forward this position clearly since it is open to conflicting interpretation. This Liberal view of education is represented by Peters and Hirst, in this country, and by Scheffler in America. The problem is that some have used this theory to support the status quo, the Traditional subject-based curriculum, whereas others have shown it to be a broadly Progressive view. The following should reveal that in fact this view of education does not support the subject-based curriculum that exists in many schools today. But first, what is the Liberal position?

In the first instance, the position is so called because it is concerned with the autonomy, rationality and freedom of the individual. For Peters, education involves the understanding of principles, the whole personality, and all-round achievement. The main aim of education is the development of rationality, which Peters claims is brought about by the acquisition of knowledge. Rationality however, is not brought about by the accumulation of items of knowledge or facts, rather:-

> "it requires reflection on what we already know so that a principle can be found to illuminate the facts." (Peters, 1967, p18).

Hirst (1965) takes Peters' analysis of education and asks, "what is knowledge?". He theorizes that knowledge is made up of Forms; these Forms have four distinctive features, namely, a set of distinctive concepts, a distinctive logical structure, criteria of testability, and distinctive methodology. And he claims, there are roughly seven Forms of knowledge (mathematics, physical sciences, human sciences, history, religious knowledge, literature and the fine arts, and philosophy).

Thus the aim of education becomes the initiation of pupils into these seven Forms of knowledge. Education concerns the development of the ability to think mathematically, historically, philosophically, and so on.

Now, an important question is, does this view justify a Traditional subject-based curriculum? It would seem that in reality, schools are not concerned with developing "ways of thinking": rather, the emphasis is on amassing a large amount of facts (often for examination purposes). And indeed some (Stenhouse 1975) have considered that Hirst's agruments are an attack on the status quo. Peters (1959) himself has this to say:-

> "....those who stress the importance of a 'liberal' education are not merely voicing a protest against an academic or vocational emphasis in education which neglects the individual needs of children... Their protest relates to the manner as well as the matter of education. For both science and arts subjects can be passed on by liberal or illiberal procedures. Literature and science can both be treated as 'subjects' and, as it were, stamped into a student. Or they can be treated as living disciplines of critical thought...." (p88).

Although the Liberal view of knowledge differs from some of the other Progressive views (for example, Dewey believes knowledge is a "seamless web", rather than a number of distinctive Forms), the importance of the first-hand experiences and individual differences between children is recognized:-

> "....the interests and needs of the child... any educator must take account of if the child is going to assimilate anything that he is taught." (Peters, 1959, p100)

Hirst suggests that the teacher:-

> "should approach his task in a way that is actually appropriate to the age and condition of the student he is teaching. So subject matter and individual differences between students are relevant considerations." (Sited by Cohen, B., 1983, p83).

Hence, there are firm reasons for accepting the Liberal view of education as being broadly Progressive.

The Romantic, the Social Reconstructionalist, and the Liberal views provide an idea of the Progressive theory of education. What are the general implications of the Progressive position?

2.2.3.4 **The Implied View Of Knowledge.**

The Progressive theory of education supports an "empiricist" view of the nature of knowledge. Knowledge, in this sense, comes from experience, rather than the mere acquisition of information. Knowledge is not believed to be fixed and unchanging; rather, it is continually evolving, and part of the purpose of education is to develop in those being educated the ability to evolve new knowledge. This may be brought about by providing pupils with the opportunity to formulate and test their hypotheses - a "pragmatic" approach.

2.2.3.5 **Implications For The Curriculum.**

The child is central to the Progressive idea of education. As this is so, central to the curriculum is the child him/herself and his/her own needs and interests. Even the Liberal view, the least Progressive, recognizes the importance of the child. Peters (1959) states:-

> "The stress on interests and needs is a necessary corrective to those who regard education just as a matter of passing on what is good for the child to know without any thought for what he may be interested in and what his particular needs may be as an individual who, in some respects at least, is different from other individuals." (p101).

In practice, children may be found working on individual or co-operative group projects. The learning activities aim to promote problem solving skills. The learner is the starting point for the learning activities, so the problems, generally, are closely related to the child's own interests. The understanding of knowledge rather than the accumulation of facts is emphasized. This understanding is thought to develop from experience, so discovery methods are adopted, and the importance of "play" recognized. The children develop their understanding of knowledge and their problem solving abilities by investigating and exploring the physical world. The teachers need to recognize the children's natural curiosity and interest and give it educative direction. Discipline and control are not emphasized, rather, self-discipline and self-control, encouraged.

This problem-centred approach is associated with integrated studies rather than strict subject boundaries, with informal, mixed ability teaching without the strict separation of the academic and practical. The Progressive view of education implies a child-centred curriculum involving pupil-based inquiry for the development of problem solving skills and understanding of knowledge.

2.2.3.6 **Implications For The Learner.**

The learner is seen as central to the whole education: s/he is recognized as an active participant in the learning process. The Progressives believe that the pupil has an innate potential for learning, and is basically well-disposed to education. Learning activities are pursued for their own sake, rather than for any extrinsic reason. The child is thought to be self-motivated by his/her curiosity and interest, and so coersion into learning by some extrinsic form of motivation is unnecessary.

2.2.3.7 **Implications For The Teacher.**

The Progressives see the teacher as some kind of guide or resource. One of the teacher's tasks is the provision of a structured learning environment that will facilitate self-learning. The teacher guides the learner's development of knowledge and skills needed for "growth" (Dewey). The teacher's task is believed not merely to involve the passing on of information. Rather, emphasis is put on the development of a critical habit of thought. The teacher guides the child's interests in an educative direction, and so develops understanding and knowledge.

Just as the criticisms of the Traditional view were considered, so, to give balance, some of the criticism voiced against the Progressive view should be considered.

2.2.3.8 **Criticisms Of The Progressive View Of Education.**

Since there are different interpretations of the Progressive theory, it might be more useful to consider briefly some of the major criticisms that have been voiced about the general implications of the theory.

There has been much discussion about basing a curriculum on the needs and interests of the learner (for instance, Hirst and Peters, 1970). It has been argued that basing a curriculum solely on the child's needs is inadequate, since it is virtually impossible to define needs: needs reflect attitudes and values, and hence, the educational needs of children seem merely to be disguised forms of value judgements. Virtually any curriculum could claimed to satisfy learners' needs.

Does basing the curriculum on the learners' interests satisfy the critics? Here the situation is more complicated since, two senses of interest have been distinguished, namely, "having an interest" (meaning that a pupil may have an interest in X without actually being interested in X, since there are extrinsic reasons for being interested in X. For example, a man learning to program computers purely because such a skill would, he believes, easily gain him a job; his interest is in gaining employment rather than in programming), and "feeling an interest" (the truer sense of interest - the learner actually being interested in X for its own sake and for no external reason). If the curriculum was based on the pupils' best interests (the first sense of interest - "having an interest") the same problem that arose with needs appears: best interests are value dependent, and any curriculum might be said to be in the pupils' best interests. If the curriculum was based on the pupils' actual interests, then the content of the curriculum would amount to the pupils' felt interests. There would then be the problem of deciding whether the curriculum should be wholely or partly determined by the child's interests. And this is debatable. But generally, the more Progressive the interpretation, the more the curriculum would be determined by the pupils' felt interests. (This of course, would lead to certain practical difficulties regarding facilitating many different interests and providing appropriate resources).

Other criticisms have been levelled at the interests based curriculum: how should interests be identified? Would children be denied certain experiences? Should the teacher promote interest? What should be done about harmful or immoral interests? There are no straight-forward answers to such questions.

Having examined, somewhat briefly, the two dominant theories of education, it should be clear that both are open to criticism. Both the Progressive and the Traditional theories involve assumptions about the "educated man", about the learner, and about the content and method of what is to be learnt. Critics attack these assumptions and their implications and recommendations for practice. The important thing is to be aware that any view of education is open to attack: this is because the assumptions that are made are ultimately dependent on value judgements. It is important to be aware of this when considering computers in education, since it is anticipated that the way in which computers are chosen to be used will be based on certain assumptions - assumptions about what education is, about the nature of the learner, and about the content and method of the curriculum. If the role of the computer in the classroom is examined in the light of these underlying assumptions, then the real implications (for practice) may become clearer.

Much of this chapter has, so far, been concerned with educational theory, and not directly with computer practice. However, rather than dismissing educational theory as somewhat dull background, it has been argued that this is a necessary prerequisite to a real understanding of the questions that are of key importance - namely, questions of the sort, "what is computer education?", "under what circumstances can computers improve the quality of the educational processes provided in schools?" and "how can computer education be researched?". To reiterate what was said in the earlier pages of this chapter, education is a contested concept so there are different ideas of what education is, and hence, different ideas about what would constitute improvement in its quality. It is hoped that having spent time on these issues, a clearer idea of the real questions involved in "computer education" will have evolved. Looking at some of the dominant conceptions of education and revealing some of their underlying assumptions, should have in turn illuminated some of the implications of using the computer in education. This "illumination" may be made more clear by directly examining types of computer use, and explicitly exploring implications for practice, thus building on some of the insights derived from educational theory.

2.3 Computer Practice.

In this section, "paradigms" of computer use in education will be employed in a way which relates computer education to the general field of educational theory. This should provide a framework for judging the extent to which the computer is being used by schools to replace or merely to reinforce existing educational policy and practice, or more importantly, (in terms of evaluation) enhance the quality of educational processes themselves.

In Chapter One it was reported that Kemmis (1977) proposed the notion of "paradigms" of computer use so that the way in which developers of computer-assisted-learning conceived their task, could be grasped. These paradigms - the "instructional", the "revelatory", and the "conjectural" - were then briefly outlined, but now need explaining in greater detail. However, it is worth drawing attention to the danger of dividing computer applications into categories: either the divisions can be seen as too distinctive or, needing no further analysis. Yet, if the dangers are avoided, then these paradigms may be utilized productively.

2.3.1 The Instructional Paradigm.

Within the Instructional paradigm, the computer acts as a patient tutor presenting drill-and-practice type lessons. The role of the computer within this paradigm, has its roots in Skinner's behaviourist theory of learning and his attempts to operationalize this theory in programmed learning. Since this is so, the subject matter, (upon which the learning is focused), is thought to be best conveyed if the knowledge to be acquired and the content to be mastered is broken down into a series of ordered steps. These steps are small enough to allow most pupils to respond correctly, in theory. Instructional programs of the drill-and-practice type, offer immediate feed-back, which either reinforces the learner's response, or directs him/her to a remedial section of the program (if there is one). In this way, learning is seen as individualized; pupils work through these programs alone, and at their own pace.

Some see that using the computer in this way has a number of practical advantages. As Rushby (1984) reports, the micro is seen:-

> "as an individual tutor of unlimited patience (albeit of limited intelligence) to each of a large number of pupils,... as a means of reducing the teacher's load,... thus freeing him to devote more effort to those parts which are taught by other means." (p31).

This outline of the Instructional paradigm has clear connections with the Traditional view of education. For one thing, using the computer in this way emphasizes the Traditional interpretation of educational knowledge as instruction and training. In addition, the Instructional use of the computer is likely to be employed by teachers who base their curriculum on subjects; the programs are limited to one specific area which will fit nicely within a subject boundary. For instance, in an English grammar lesson, an appropriate drill-and-practice program might be employed to reinforce, or make more effective, the teacher's lesson. Using the micro in this way has implications for the learner also, which tie in with those of the Traditional theory of education: rather than the children being active participants in the learning, Instructional programs put them in a passive position; a position in which response, rather than initiation, is required.

This passive role, which the pupil is encouraged to enact, has lead to criticism of Instructional programs. Critics attack these mechanistic drill-and-practice routines which merely allow the pupil to respond passively, and those most vehemently critical, argue that as a result, the learner "is programmed rather than programs" (Papert, 1980).

Such programs are also criticized for assuming that all pupils have the same style of learning: no account is made for different aptitudes, attitudes, moods, or gender. Such software also assumes that questions have one right answer; Instructional programs do not respond to divergent answers or ask divergent questions. This may discourage natural language development and encourage a mechanical way of thinking and responding. Critics argue that pupils may unconsciously come to devalue their own personal knowledge, and passively accept the computer's apparent authoritative answers (about what is right/wrong, good/bad).

The educational validity of drill-and-practice programs, and other software which assumes a behaviouristic model of learning, is questionable. Computer based learning within this paradigm assumes an atomistic theory of knowledge: the subject matter must be broken down into a number of clearly defined and finite goals which are then presented in a sequential order. However, it can be asked if all subject areas can so be broken down, and whether it is really desirable to do so. Such a procedure tends to reduce knowledge to facts: is it always desirable to banish complexity? "Education" may result in little more than the accumulation of "items of knowledge". And emphasis on facts may forsake real understanding and critical thinking. There is the additional danger that knowledge which can be broken down into steps and programmed onto the computer, may be given a more central place on the curriculum. For example, in the case of mathematics, as computational exercises are easier than mathematical concepts, to program, the former may be emphasized at the expense of the latter. Yet, the acquisition of mathematical concepts is essential for a real understanding of the subject.

Kemmis and colleagues (1977), speak critically of this type of use. From their experience, it:-

> "seemed to be concerned with 'low-level' learnings like the acquisition of information and the inculcation of simple skills and seen by teachers' lights to undervalue the educational process: it seemed to mistake crude indicators that some learning had taken place for the richness and subtlety of the process of coming to understand. It appealed most to those who wanted to increase the efficiency of the learning process and for whom the question of what is learned was relatively unproblematic." (p37).

2.3.2 **The Revelatory Paradigm.**

Within this paradigm, the computer is used to present a simulation of a real world situation. To explain further, a typical program might simulate a particular environment which is consequently manipulated by the learner in order to discover the principles that govern it:-

> "As the learner interacts with the model hidden within the computer he develops a feeling for its behaviour under various circumstances and so is lead to discover the rules which govern it."
> (Rushby, N. 1984, p32).

So, as the name suggests, the rules governing the simulation are gradually "revealed" to the learner.

Often simulations are of dangerous or costly experiments, or ecological environments. But there is also another type of simulation program which is purposely not based on a real world situation. These are the "adventure game" type programs, programs which simulate an imaginary world which the learner can explore, investigate and attempt to discover the rules which govern it. Such programs, like "Granny's Garden", "The Flowers Of Crystal" and "Suburban Fox", are becoming increasingly popular in primary schools. The learners' interaction with the computer is much more active than in the Instructional paradigm, although the machine remains in ultimate control of the situation; the rules of the simulated environment are pre-set and unchanging.

Just as the Instructional paradigm is underpinned by a Traditional theory of education, so the Revelatory paradigm tends to fit in with a Progressive view of education. Programs within the Revelatory paradigm encourage problem solving and learning by discovery, rather than focusing on the subject matter itself and the child's ability to rote learn the facts, as within the Instructional paradigm. This has implications for the curriculum: a Progressive organization of the curriulum is more suitable since many of the revelatory programs are not subject specific. For instance, the "adventure games" are sometimes used as the core of a term's project work, involving study which covers many of the Traditional subject boundaries.

As for the learners, they are placed in a more active role when the computer is used within the Revelatory paradigm. Children are active in the sense that such programs encourage them to work together as a co-operative group, and discover the rules of the simulated world. They are put in a decision-making position where questions of the type, "what if....?" are raised. Also, since the learners usually work in groups, if one member proposes a course of action, the others will often demand a justification.

This has implications for the teacher. Since the children are actively involved in problem solving situations, the teacher will not be in the role of an authoritative instructor. Rather, children will call upon the teacher when they are in difficulty, and use the teacher more as a guide or resource. The teacher's main task will be the setting up and maintenance of an environment which facilitates self-learning.

Since the Revelatory paradigm is underpinned by a Progressive view of education, it is open to the criticisms levelled against the Progressive theory and all its assumptions. In addition, the Revelatory paradigm does make certain other assumptions: it is assumed that pupils are able to make the leap from a real-life situation to a computer representation, and with "adventure" programs (which are not intended to model a real situation), it is assumed that the pupils accept the imaginary world for what it is, (a fictitious environment) but at the same time, believe in it for the purposes of exploration. As far as real-life simulations are concerned, it is questionable that what is learnt from the model is anything like what would be learnt from a practical experiment. For instance, a computer simulation of a river-bed environment might be used for pupils to investigate the process of erosion. Alternatively, pupils could be taken on a field-trip and allowed to examine the real-life situation. Although the latter would certainly have its practical problems, it would probably provide a most memorable and rewarding experience, whereas the computer simulation might be over simplified, and first-hand practical experimental skills would not be acquired. A simulation is only a representation, and before all practical and fieldwork activities are replaced by computer simulations, it would be important to consider what might be lost. Further, it is assumed that the learner comes fresh to the simulation. There is always the danger that the pupil may "learn" how to manipulate the environment successfully without going through the problem solving activities needed to discover the underlying rules for him/herself, and, with real-life simulations, without understanding the real environment it represents.

2.3.3 The Conjectural Paradigm.

Chapter One defined the Conjectural Paradigm as computer use which helps the learner formulate and test his/her hypotheses. Rushby (1984), defines the computer's role as:-

> "assisting the pupil in his manipulation and testing of ideas and hypotheses." (p33)

Within this paradigm, the computer is suitable for model building. In some respects, the Conjectural and Revelatory paradigms are similar. Both use the micro to evaluate some kind of environment in order that its behaviour can be studied. Model building within the Conjectural paradigm is similar to simulations within the Revelatory paradigm. The main difference concerns the role of the learner: with simulations, the pupils cannot alter the equations which control its behaviour; the computer is ultimately in control of the situation. With modelling, the pupil can specify some parts, or add to the model; the computer is under the learner's control. The computer provides a problem solving environment which allows learners to formulate and test hypotheses about the system under investigation, and hence the learner is in control. Computer use within this paradigm emphasizes the development of concepts and understanding, rather than the acquisition of facts (as within the Instructional paradigm). It holds the promise of being an effective device for acquiring cognitive processes - the teaching of how, rather than what, to think (Lockhead & Clement, 1979). An example is the computer language Logo, which was developed for use with children. Logo might be used not only to develop children's concept of geometry and shape, but also, problem solving and procedural thinking skills. Logo and its philosophy will be studied in Chapter Seven.

Some might form the impression that concept development is in some way restricted to mathematics and science. However, the construction and testing of hypotheses is also an essential part of the development of an understanding of English and history, for instance. Databases can be utilized for the testing of theories within these areas.

As with the Revelatory paradigm, the Conjectural paradigm is underpinned by a Progressive theory of education. The use of the computer within the Conjectural paradigm has similar implications for the curriculum, the learner and the teacher. Within the Conjectural paradigm, as Kemmis and colleagues (1977) point out:-

> "many of the important student experiences take place away from the computer. People who operate within this paradigm tend towards the view that knowledge is created through experience and evolves as a psychological and social process." (p26).

Within the Revelatory paradigm too, much of the pupil's time might be spent working away from the computer (for example, this happens when an "adventure" program is the focus of a term's work), and knowledge is not acquired in "bits" thought of as facts. The Revelatory paradigm and the Conjectural paradigm have similar implications since they both assume a Progressive view of education. There are differences, but they tend to be of degree only. For instance, within the Conjectural paradigm, the learner is more active and has more control over the micro. Rushby (1984) comments:-

> "Because... it is the pupil who is in control of the learning rather than the other way about, he is brought much closer to instructing or programming the computer than in the instructional or revelatory forms." (p33).

The teacher's role is somewhat different too. The teacher's guidance is crucial, but how and when to intervene is often problematic. Kemmis and colleagues (1977) explain:-

> "Perhaps the biggest difficulty in practice within the Conjectural paradigm is that of developing students to the point where the machine becomes a 'mere' tool for the pursuit of other learning. On the one hand, there is the problem of helping computer-naive students to use the machine as a 'scratch-pad' when the ideas they are pursuing are themselves complex and subtle; then, on the other hand, there is the problem of helping them, after they have reached this level of mastery of the machine as a tool, to free themselves from the categories it imposes on the way they think about the problems." (p32)

As was mentioned in Chapter One, Kemmis and colleagues also suggest a fourth paradigm which they term the Emancipatory paradigm.

2.3.4 The Emancipatory Paradigm.

Put briefly, in this case the computer is used to reduce "inauthentic" labour. Inauthentic labour is a necessary part of a task, usually requiring a large amount of time, but no real skill; activities that may be instrumental to valued learning, but which are not valued for their own sake, (Kemmis and colleagues, 1977). For example, statistical calculations often involve inauthentic labour. Once the procedure to perform these calculations is known and understood, then the actual process of adding up a list of numbers and dividing by the number of numbers in order to find the mean, for instance, is a time-consuming and chore-like task, especially when the result is (usually) what is important. Other examples of inauthentic labour include such activities as thumbing through books, looking for appropriate references, or placing words in alphabetical order (assuming the learner already knows how to do this). In the Emancipatory paradigm, the computer can help reduce the work-load of the learner, freeing him/her for more authentic work (valued learning).

The role of the computer within the Emancipatory paradigm is limited to a time-saving role in which the demands for inauthentic labour can be reduced. In this sense, the computer can help reduce the amount of time spent on tasks which are necessary but which have no educational value. In this way, an emancipatory use of computers could promote educational processes. This use should perhaps not be under-estimated for, as some statisticians would argue, without the computer, many calculations which are performed would take a very long time, or be virtually impossible. The computer can be a very efficient and relatively reliable machine, as Rushby (1984) writing about computer use within the Emancipatory paradigm says:-

> "The computer is a machine which excels at rapid, accurate calculation and information handling, and is a very suitable means of reducing the amount of inauthentic labour in the learning process, supporting the pupil by providing him with facilities for calculation, information retrieval and so on." (p35).

This is an important and useful role for the computer, but it is wise to recognize that such applications of the computer in educational settings may be justified in quite a different way: this fourth educational paradigm differs importantly from the other three. Computer use within the Instructional, the Revelatory and the Conjectural paradigms may be justified by its advocates on the grounds that it enhances the quality of the learning experiences, whereas the justification for computer use within the Emancipatory paradigm is based on the grounds that it reduces inauthentic labour, (so potentially improving the quality of the learning experiences). The use of the computer within the Emancipatory paradigm does not of itself clearly relate to particular views of education. For instance, the computer can be used as a word processor - the educational value of this use is only revealed when the reasons behind so using it are uncovered.

In this chapter, time has been taken to examine the notion of "education" and its dominant theories, as a prerequisite to understanding the question "under what circumstances can the computer improve the quality of the educational processes offered by schools?" and other questions like it. Such study paved the way for the final section, on computer practice, in which paradigms of computer use, and the way in which they relate to educational theory, were examined.

The next obvious step is to move towards assessing the way in which computer uses can improve the quality of educational processes. The following chapter examines the meaning of quality and then moves on to look at approaches to evaluation, so preparing the ground for the empirical study of computer education.

Chapter Two: Notes.

{1} (see pages 36 and 42) Moore (1974) points out a distinction between "limited" and "general" theories of education. Briefly, he says that:-

> "limited theories of education involve prescriptions of a mainly pedagogical kind, about the most effective ways of teaching... they do not themselves involve any comprehensive notion of what 'education' is or what its purpose is. Their connection with 'education' is only contingent since they could be effective in situations where we might hesitate to say that 'education' was going on at all." (p12/13).

General theories, on the other hand:-

> "include not simply recommendations about the conditions of effective teaching but recommendations for producing a certain type of person, sometimes even a certain type of society... They are concerned with the making of an educated man, and... recommendations cover not only what they (the theorists) consider to be the best ways of teaching but also what is to be taught and to what end." (p13).

Chapter Three: EVALUATING COMPUTER EDUCATION.

This thesis argues that computers should be used in primary schools in ways which improve the quality of educational processes, and, that the term "computer education" may only validly be used to refer to activities in which computers do this. However, this agruementraises many questions. Some of these have already been considered (What is education? How do computers relate to educational theory?). What now needs to be considered is the sense(s) in which the computer can "improve the quality" of educational processes. Is the improvement in terms of the instrumental efficiency with which existing curriculum objectives are pursued, or is it improvement in the quality of the educational processes themselves? The first part of this chapter examines the meaning of "quality". The second part looks at different approaches to evaluating quality in education.

3.1 The Meaning Of Quality.

The uses of the micro in education are many and varied, and there exist different criteria by which the success of the computer in education can be assessed. The different criteria can be related to the two dominant views of education in the sense that the Progressive and Traditional view imply different interpretations of "improvement in quality". Likewise, the criteria can be related to the three (or four) paradigms, examined in Chapter Two, since they reflect different ideas about education and imply different interpretations of "improvement" in the "quality" of the educational provision.

One set of criteria relate to improvements in quality in terms of improvements in the means of achieving the end product. The computer could be an instrumental means to a given end. For example, a drill-and-practice program might be thought of as "successful" if the majority of the class "learn" the material in the program. In this instance, the criteria relate to the computer's achievement of its objectives, and in a broader sense, its ability to make more effective or efficient the achievement of those curriculum goals; the quality of the computer is measured in terms of improvements in effectiveness and efficiency, rather than improvement of the educational process itself. Improving the quality could relate to the latter, where the curriculum emphasis is on process, in the sense that the ends are realized in and through the "means", and the computer has the potential to improve the quality in this more important sense.{1}

Can the use of the computer be judged to be successful if it simply enables the school to achieve its existing goals more efficiently, or in a more effective manner? Speaking of the computer in school, Kelly (1984) recognizes that:-

> "....a major feature of its current use is as a sophisticated teaching aid, a device to enhance and perhaps accelerate learning of a traditional kind... The microcomputer is seen as little more than a new and highly efficient form of teaching machine." (p.xiv).

Others too have recognized that the computer can be used to improve the efficiency or effectiveness of the existing curriculum. For example, Fothergill (1982) considers that the computer can be of considerable value in a wide range of subjects:-

> "Perhaps the one that springs first to mind is its use in helping children learn more effectively in all the central disciplines of the curriculum through the use of specially designed programs." (p11).

The old instructional methods used by the new technologies may improve the effectiveness and efficiency of educational provision; computers may be instrumental in achieving the given end, but does this amount to an improvement in the real quality of the educational process?

> "it is important to understand very clearly that strengthening a particular technique - putting muscles on it - contributes nothing to its validity." (Weizenbaum, J., 1976, p34).

Using the computer may make the curriculum technique stronger, and better at achieving the goals, but it does not improve the value of those goals. And, is putting muscles on the Traditional content and method of teaching, using the computer to its full potential? Woods (1983) reports:-

> "Some experts feel that the micro is not yet being applied in the proper way. George Blank, editorial director of Creative Computer magazine, puts it in this way: 'most present efforts to use the computer in the classroom are an attempt to simply do a mechanical translation of current classroom techniques in the computer environment rather than take advantage of the special abilities of the computer, and design a new way of teaching." (p91).

If computers are used merely to present "mechanical translations of current techniques", then the "ends" which the computer serves will remain unquestioned. In other words, the computer will be used to reinforce the status quo rather than fulfil the potential it has to transform and improve the quality of the educational process itself. Golby (1982) expresses such concern:-

> "....we should be concerned with qualitative change in the educational process rather than with the simple addition of new means to old ends or old wine in new bottles." (p205).

The arrival of the computer in some schools is in reality "innovation <u>without</u> change". Golby continues:-

> "It will be a great pity... if teachers should become seduced into taking more effective means to unconsidered ends." (p211).

Focusing on improving efficiency or effectiveness would be a great pity; there is the danger that it would constrain the curriculum and the teaching and learning methods: supporting the status quo does not lead to change of course, and without change, there cannot be extention or improvement of the curriculum. In fact, it might even lead to a decline in the quality of the curriculum; the computer might be used to substitute other methods which could have carried out the activities as well, or even better. As it has been said earlier in this thesis, thinking about computers and primary education does not mean thinking about computers: it means thinking about education. This is a central, but frequently ignored realization; it cannot be repeated too often. Computers have the potential to radically improve educational processes, and yet, ironically, since they are so often thought of in terms divorced from "education", their introduction in schools simply leads to no real change, no real improvement of quality.

Rheingold (1983) comments on earlier days:-

> "The teaching machines of the computer-assisted instruction transferred declarative knowledge with assembly-line efficiency but did nothing to upset the stale notion that learning is little more than the acquisition of facts." (p38).

In relation to this, Weizenbaum (1976) poignantly remarks:-

> "A person falling into a manhole is rarely helped by making it possible for him to fall faster and more efficiently." (p35).

If the educational provision is unsatisfactory, then however much efficiency is improved, the quality of the educational processes will remain unchanged. The criteria by which computer education is assessed could relate, more importantly, to the computer's ability to improve the quality of the educational process itself, rather than making more efficient the achievement of the existing aims. The fundamental difference between these two ways of judging the successfulness of computers in education needs to be realized. These two ways are also reflected in the different approaches to educational evaluation.

3.2 Approaches To Evaluation.

As the above heading might suggest, evaluation in education is problematic: there is no single agreed approach to evaluation.

Evaluating something basically involves trying to find out whether it is any good. White (1971) argues that:-

> "things can be good in many different ways: people and actions can be morally good; paintings and poems can be aesthetically good: a knife or a car can be instrumentally good, i.e. as an efficient means to an end - and so forth...."{1}

And continues:-

> "Like anything else, a new curriculum can be evaluated in all sorts of ways." (p388).

The previous section has indicated the sense of improvement in quality with which this thesis is concerned, namely the computer's ability to improve the educational processes. What is the most appropriate way of evaluating this sense of "improvement in quality"?

The many different approaches to evaluation have been delineated by various writers in the field. Reid (1981), for instance, identifies four perspectives: the Systematic (basically an evaluation of efficiency and effectiveness of means rather than ends); the Radical (an approach which centres on the control of evaluative activities, and one which assumes that the dominant ideologies influence the whole process); the Existential (evaluation which concentrates on the personal meanings and interpretations of those involved in the educational program) and the

Deliberative (evaluation based on the self-critical reflection of those involved in the educational programme and consequently, practical action tends to result).

Lawton (1980) on the other hand, isolates six different approaches to evaluation:-

(1) The Classical (or agricultural-botanical).

(2) The Research and Development (or industrial, factory).

(3) The Illuminative (or anthropological, responsive).

(4) The Briefing Decision-makers (or political).

(5) The Teacher as Researcher (or professional).

(6) The Case-study (or eclectic, portrayal).

There are obvious overlaps between Reid's (1981) and Lawton's (1980) classification of the different approaches to evaluation (for example, Reid's "Systematic" and Lawton's "Classical", and the "Deliberative" and the "Teacher as Researcher" categories are very similar). Likewise, overlap can be seen between these and other attempts to classify approaches to evaluation. For example, House (1980) comes up with the following eight models: Systems Analysis; Behavioural Objectives; Decision-making; Goal-free; Art Criticism; Professional Review; Quasi-legal, and Case-study.

Stake (1981) has also attempted to provide a spectrum of evaluation approaches, which he calls "persuasions", as opposed to "prescriptions", since he believes each position is not a discrete model, but rather a persuasion through which advocates promote their own concerns. The following persuasions are identified: the accountability; the case study; the connoisseurship; the democratic; the discrepancy; the ethnographic; the experimental; the goal-free; the illuminative; the judical; the naturalistic, and the responsive.

Once again, overlap can be seen. For example, House's (1980) case study approach is similar to Stake's (1981) persuasions (2), (7), (10), (12) and (13). In addition, Stake (1981) points out overlap between his own persuasions.

However, at the risk of over-simplying, it can be suggested that there are basically two general styles of approach to evaluation, namely, the "product", means-ends, objectives type, and the process approach, and also it can be revealed that underlying each model of evaluation are interpretations of education. Most approaches could be said to adopt one of these two models. Approaches to evaluation may be distinguished on these grounds, yet it would not be incompatible to see all the various approaches to evaluation as lying along a kind of continuum, with the agricultural-botantist, behavioural objectives approach at one end, and the more illuminative approach towards the other end. In any case, any kind of classification must be taken tentatively, since "in a sense every approach has some unique feature" (House, 1980, p326). But on the other hand, some kind of categorization helps clarify the different perspectives on evaluation. And it would seem that the more important difference is highlighted when the "means-ends" and "process" classification is employed.

Before this classification is utilized, the two terms can be examined in more detail, and related to the evaluation of computer education.

3.2.1 The Means-Ends Objectives Approach.

This is the dominant approach to evaluation, concerned with how effective a curriculum is at achieving the given ends. The curriculum is assessed in terms of its achievement of goals or objectives, rather than in terms of whether the goals themselves are "good". In this sense, a "good" curriculum is one that is an effective or an efficient means to an end, i.e. one that is instrumentally good; for example, Reid's "Systematic", Lawton's "Classical", and House's "Systems Analysis". The evaluation of the curriculum usually centres on observable behaviour (of teachers, pupils). Learning outcomes are measured, by achievement tests, and from these figures, elements of effective teaching are isolated. In this way, the means-ends model evaluators generalize that adopting method X results in the effective/efficient achievement of prespecified learning outcomes Y.

In the case of computer education, the use of the microcomputer is considered to constitute an improvement to the curriculum if it has improved the effectiveness/efficiency of the achievement of curriculum goals. If this approach was adopted then the empirical research would centre on the testing of the hypotheses if X then Y. If an aim of the curriculum is the promotion of the memorization of multiplication tables, for instance, then the microcomputer will be judged as having improved the quality of the curriculum if it turns out that it is a more effective or efficient means of getting the pupils to learn their tables than the methods previously used. It can be seen that the means-ends model implies a particular view of quality and its improvement: improvement in quality is seen in terms of improvement of efficiency or effectiveness, rather than improvement of the value of the curriculum goals themselves and the educational processes.

Since this approach is essentially concerned with evaluating means, its execution is relatively straight-forward; the ends are assumed, and thought to be unproblematic. Consider the behavioural objectives approach which has been examined by Stenhouse (1975), who writes:-

> "...it is important to be clear about what a curriculum is trying to do. Clarity is to be achieved by demanding that the developer of a curriculum state the aims of the curriculum in terms of behavioural objectives, each of which 'must describe an observable behaviour of the learner or a product which is a consequence of the learner's behaviour'. (Popham, 1965, 35).... This approach to evaluation is essentially one of measurement." (p99/100).

In this case the curriculum is evaluated in terms of its effectiveness in meeting its objectives. As a result, this and the agricultural botany approach to evaluation is claimed to be value neutral: assessing effectiveness or efficiency can be divorced from judgements of value, but the claim of value neutral-ness is the source of one of the major criticisms of this type of approach to evaluation. Such methods may well evaluate whether or not the curriculum is an effective means to achieving predetermined outcomes, but they fail to evaluate whether or not the given objectives are in themselves educationally desirable. They are simply assumed to be desirable. But such an assumption, if examined, can never be value neutral. Hamilton (1976), argues that any approach to evaluation cannot be completely divorced from values on the grounds that:-

> "The selection of topics for investigation, the collection of data, the choice of sampling techniques, and the presentation of results also reflects a 'constellation of values'". (p95).

Something more than the evaluation of effectiveness or efficiency is needed. A "good" curriculum must be educationally worthwhile, not just "good" as far as efficiency is concerned. Stenhouse, (1975) states:-

> "The curriculum must be attempting something worthwhile, as well as achieving what it attempts." (p103).

It will be seen that the process approach concerns itself with more than the evaluation of effectiveness and efficiency.

3.2.2 The Process Approach.

The process model differs fundamentally from the means/end model. Promoters of the process model (Stenhouse, 1975; Elliott, 1976) point to a flaw in the thinking of educational research in terms of "means" and "ends". Rather, in education, the "means" <u>is</u> the "end". To explain, consider this example: suppose a curriculum concerned with modern social issues has, as one of its aims, the understanding of controversial matters. The means of achieving this end is embodied in the end itself; a certain method necessarily follows from the aim. Controversial matters, by their nature, do not have one right, black and white answer, and if the aim is to promote "understanding" then it would be illogical to employ a method that encourages rote learning and memorizing. It is in this sense that means and ends are not distinct. Stenhouse (1975) writes:-

> "It is possible to select content for a curriculum unit without reference to student behaviours or indeed to ends of any kind other than that of representing the form of knowledge in the curriculum. This is because a form of knowledge has structure, and it involves procedures, concepts and criteria." (p85).

He explains that a general aim of "understanding" could be analysed into principles which would direct the process of teaching and learning ("procedural principles"); the aim would be incorporated in the methods of teaching and learning. So a teacher who used his/her position of authority could not allow the pupils to develop their understanding of controversial issues. Only a teacher that taught in such a way that allowed pupils to develop their different opinions would be acting consistently with the general aim. The aim implies "principles of procedure". Hence teachers whose teaching was consistent with the inherent principles of procedure would be acting in a worthwhile manner (provided the procedures were judged to be worthwhile), despite the learning outcomes of the pupils. Stenhouse comments on the objectives model:-

> "The formulation of a schedule of behavioural objectives helps us little towards the means of obtaining them." (p87).

Whereas about the model he advocates, he writes:-

> "The analysis of the criteria for worthwhile activities and of structure of activities deemed to be worthwhile appears to point much more clearly to principles of procedure in teaching." (p87).

Stenhouse's development of the "process model" stems from Peters (1959) who argued that education is concerned with activities that are worthwhile in themselves rather than as a means towards objectives, and that educational aims specify what is to count as a worthwhile educational process rather than its extrinsic outcomes. Peters (1959) explained that general aims imply certain principles of procedure by way of an anology. He writes:-

> "The Puritan and the Catholic both thought they were promoting God's kingdom, but they thought that it had to be promoted in a different manner. And the different manner made it quite a different kingdom." (p95).

Similarly, both the Progressive and the Traditional teacher aim to promote education, but the very different manner in which they go about it creates very different classrooms: their general, differing educational aims and values imply certain differing principles of procedure. It is not a case of selecting the best means for the achievement of aims; rather, the aims themselves imply a way of going about things. Means and ends are inextricably entwined in education. The means-ends model assumes an instrumental view of education. But educational "ends" specify what is to count as a worthwhile educational process, rather than extrinsic outcomes. Evaluation within the process model centres around the educational processes rather than around products or outcomes. Evaluation is therefore concerned with investigating the educational worth of the processes themselves. Such assessment is not straight-forward or easy to measure. It cannot be assessed in terms of observable behaviour. It has also to be concerned with the beliefs, intentions and meanings of those involved (teachers, learners). Teaching is thought to concern the promotion of understanding and understanding cannot be evaluated by the means-ends model; quantifiable learning outcomes do not reflect understanding. In evaluating principles of procedure the means-ends model is inappropriate since it cannot be predicted what constitutes a successful performance. The process model focuses on the quality of learning, not the quantifiable aspects. Improvement in quality, in this sense, concerns improvement in the educational value of the processes themselves, but this sense of quality is not easy to evaluate. However, it is more important, as Stenhouse (1975) says:-

> "....in order to evaluate, one must understand. It can be argued that conventional objective-type evaluations do not address themselves to understanding the educational process. They deal in terms of success or failure. But a program is always a mixture of both and a mixture which varies from setting to setting." (p109).

The approach to educational research and evaluation which embodies a process model is more aware of the dilemmas and ambiguities, conflicts and contradictions of education. If a process model was adopted in this research, then computer uses would need to be assessed, not in terms of student outcomes, whether a particular use effectively enables pupils to do X, Y and Z, but in terms of whether the computer promotes worthwhile educational processes. Evaluators adopting this approach will be aware of the need to assess whether certain ways of using the computer enhance educational processes themselves. A "good" curriculum in terms of the process model, is one which offers experiences of educational value to the pupils; it cannot be judged as "good" if it is merely effective in achieving its ends. But in accepting this, it will be understood that there are no clear cut answers since any judgement about improvement of educational processes will inevitably be tied up with values. The process model implies a very different form of evaluation than the means-ends objectives approach.

There are two distinct approaches to educational evaluation each reflecting two different views of education. And, as the following chapter will reveal, these two approaches reflect two broad perspectives of educational research as well. Research and evaluation are not always easily distinguishable and, it is clear that the difference between evaluation and research is essentially one of degree only. But before approaches to educational research are considered, it may be useful to briefly summarize and relate the sections of Chapters Two and Three.

3.3 Summary.

What I have tried to show in Chapters Two and Three is that the success of the computer in education should relate to the computer's ability to improve the quality of the educational processes offered by schools, rather than simply improve the effectiveness of achieving given outcomes. If it is to be claimed that the computer can be used to improve the educational quality of curriculum provision, then it needs to be shown how it can improve upon the existing educational processes.

From the examination of approaches to curriculum evaluation, two major, contrasting perspectives have arisen. What I have also tried to show is that the ways in which the term "computer education" is interpreted and the way in which evaluation is understood, go together. The major difference between the two centres around the interpretation of education; one assumes an instrumental view of education, and the other a process view. These views of education have implications for the understanding of computer education and how it might be evaluated. The following table outlines these and other interconnections.

EDUCATIONAL THEORY	Traditional	Progressive		
		Romantic	Social Reconstructionalist	Liberal
VIEW OF THE CURRICULUM	subject-centred (product)	child-centred (process)		
VIEW OF THE LEARNER	passive	active		
ROLE OF THE TEACHERS	instructor	resource/guide		

PARADIGM OF COMPUTER USE	Instructional	Conjectural	Revelatory
IMPROVEMENT OF QUALITY	increase of effectiveness of educational methods	enrichment of educational processes	
APPROACH TO EVALUATION	Means-ends objectives	process	
RESEARCH PARADIGM	Scientific	Interpretive	
METHODOLOGY	quantitative	qualitative	

This table is a brief summary of much of what has been revealed in Chapters Two and Three. It also usefully shows the interconnections between different strands of educational thinking.

The problem of this research concerns the role of the computer in the improvement of educational processes in primary schools. Since one of the main purposes of this thesis is to explore this problem empirically, the next chapter addresses the question of a suitable research paradigm and methodology. The last two rows of the table look towards this.

Chapter Three: Notes.

{1} (see pages 68 and 71) R. S. Peters (1969) has rigourously considered the issue of quality in education. In his study, ("The Meaning Of Quality In Education", contained in Education and the Education of Teachers, 1977), he explains that, for instance, one of the distinctive qualities of a knife is its ability to cut: a knife of quality is one that is good at cutting. The quality is valued for instrumental or extrinsic reasons. However, take, for example, a painting:-

> "quality in a painting... is derivative from intrinsic qualities which it possesses as a work of art." (p24).

Before something can be assessed for its quality then, it must be decided if it is to be judged on instrumental/extrinsic grounds (as with the knife), or on intrinsic grounds (as with the painting). Then further, it must be assessed whether the thing "possesses these attributes to a pre-eminent degree" (p25).

Peters (1969) states that there must necessarily be multiple criteria involved in talking about quality in education (p28).

> "what is at issue here is the different frame of reference within which what goes on in schools and colleges is now being viewed, which will determine the type of quality assigned to it." (p36).

What goes on in schools can be viewed and judged in an instrumental or extrinsic way:-

> "so an economist might think of schools in relation to their ability to provide relevantly trained manpower. He would, therefore, tend to think of quality in terms of efficiency of training relative to the type of posts to be filled, and efficiency of selection in routeing the right sort of personnel to these posts." (p36).

The alternative is to base judgement on purely intrinsic grounds. The intrinsic quality of education can be of two types. On the one hand, quality can be understood in terms of how the "products" (the children leaving school) approximate to the concept of the educated man (the "product" criteria of being educated). On the other hand, quality can be understood in terms of the extent to which the <u>processes</u> of education employed have their desired effect (the process criteria of educational procedures).

For Peters, of course, the <u>product</u> criteria of being educated involve those criteria identified in his analysis of the concept of education ("commitment to what is regarded as valuable in itself", "knowledge and understanding" and "wholeness"). Hence, Peters argues that quality in education can be considered in terms of these three general criteria. However, quality in education may also be considered in terms of the quality of the educational processes being employed, what Peters calls the "process criteria of educational procedures".

> "we can say that education has quality if it exhibits some of the criteria associated with 'education', in either the product sense or in the process sense, to a pre-eminent degree." (p33).

PART TWO:

METHODOLOGICAL CONSIDERATIONS.

Chapter Four: METHODOLOGICAL PROCEDURES.

This chapter falls into three parts. The first part is concerned with approaches to educational research and considers two research "paradigms". The second part explores case study, the methodological approach used for this research. Sections consider methods of collecting and analysing data, and arguments for, and criticisms of, case study research. The third part examines the use of case study in this research, its suitability, the cases chosen and the reasons for selection, together with the methods employed in the collection and analysis of data.

The main concern of this thesis is with the potential of the computer to improve the quality of education provided by primary schools. To what extent can the computer be used to enrich educational processes? Microcomputers have now entered most primary schools, yet it is not at all clear why; nor is it entirely obvious how they can make a real contribution to the improvement of the educational process. Is the computer "a solution in search of a problem" as Weizenbaum (1980) has suggested? The practice of "computer education" is diverse; the interpretations of its concerns are various. The major question which is largely unasked is "what kind of computer use can and will promote the development of <u>educational</u> processes in primary schools?". What is now needed is a way of exploring this question empirically; a way of assessing whether the computer is being used in practice to simply mechanically translate current provision, or whether, and how, it is being used to enhance the quality of the process of education itself.

There are a number of possible ways in which the purpose of microcomputers in primary education could be empirically researched. Research and evaluation techniques are numerous - tests, surveys, questionnaires, interviews, observations, and many more. But underlying these various methods and techniques there are, broadly speaking, two research styles each offering different views of the potential value of the different techniques of educational research and evaluation. A decision as to the most appropriate and suitable mode of empirical investigation has to be made, and in order to do this, the choices need to be briefly reviewed. A general view of the central conflicts and controversies in and about educational research and evaluation will be briefly presented so that the most suitable methodological style, for exploring the problems addressed by this research, can be wisely selected. To this end, the salient features of the two positions will be outlined, and their implications assessed.

It is worth noting at this stage that the choice of research methodology is not a straight-forward one between these two, often rival, positions: the choice is not necessarily "either/or". There can be strength in combining methods from both positions, as should become clear. However, for the purpose of exploring the approaches to research, it is useful to consider the methods as belonging to one of the two, broadly different, positions.

The different paradigms of computer education were considered earlier. Likewise, it could be said that the opposing methodological positions represent "paradigms" of educational research. An examination of the different approaches to research, and the possibility of "paradigms", is the concern of the first part of this chapter.

4.1 "Paradigms" Of Educational Research.

In recent times, the word "paradigm" has become somewhat fashionable in educational research. It derives, of course, from the seminal work of Kuln, (1970) for whom a "paradigm" refers to the conceptual frameworks necessarily underpinning scientific inquiries. The particular framework, or paradigm that is presupposed by researchers, structures the way they go about research; the way observations and experiences are interpreted, the way in which a research problem is defined and the way it should be studied. The two currently dominant paradigms in educational research represent two different ways of looking at research problems, the methods and techniques for gathering data and the interpretation of it. Depending on which of the two contrasting paradigms the researcher espouses, s/he will tend to:-

> "ask certain questions and not others; ...adopt certain research methods rather than others; ...show a preference for certain kinds of analysis, explanation and theory...." (Cohen and Manion, 1980, p27).

Before examining these paradigms, it can be reiterated that although they represent rival perspectives, at the same time they should not be viewed as completely separate, and although the questions raised in the research will more appropriately relate to one paradigm rather than the other, the choice is not a straight-forward one of selecting one method in preference to another. Rather, the problem is to determine when and if each methodology is appropriate. At times, aspects of the research problem may best be tackled in a manner which may conflict with the general paradigm presupposed. Rather than judged as contradictory, such decisions, wisely made, should be seen as complementary and shedding further light on the problem under investigation. But what of these educational research paradigms?

4.1.1 The Scientific Research Paradigm.

The first of these research paradigms may be termed "scientific". Its basic assumption is that the scientific methods used to investigate natural phenomena may be applied to social phenomena as well. The educational researcher's role within this paradigm is, like the natural scientist's, one of detachment and neutrality. The aim is to produce an analysis of data which is objective, quantifiable, explanatory, publically verifiable and replicable. The philosophical outlook most commonly associated with this paradigm is usually labelled "positivism" and it has certain implications for educational research. The first of these implications is that the scientific approach, with its methods of natural science, is applicable to educational research. And the second is that such research should be subject to the standards of scientific research. Therefore, it is claimed (O'Connor, 1957 and others) that educational research should adopt a more objective style, by using the methods of science. Scientific methods (mainly the hypothetico-deductive, where hypotheses are proposed and deduction assessed by observation) should be employed since these are free from subjectivity and personal bias. Thus, if these methods are employed, what is really happening in educational situations will be revealed, so those who advocate the scientific paradigm argue.

The scientific paradigm is often linked with the means-ends model of evaluation. The simple explanation as to why this is so is that the means-ends model of evaluation and the scientific paradigm hold similar assumptions about the nature of knowledge and the view of education. This is reflected in the emphasis on observable behaviour and the assumption of value-freedom, common to both. However, a paradigm of educational research does not of itself define the research methods. Methodological techniques are not confined to a particular paradigm and "scientific" research need not necessarily be means-ends research; "scientific" research could be concerned with educational processes, although this is not common.

The research methods usually associated with this positivist paradigm are "quantitative". Such methods deal with measurement, with results represented by statistics and percentages most often; quantitative research quantifies that which it investigates. Take for example the pre-test, post-test procedure involving experiment and control; the results are in terms of measured outcomes. If the central questions of this thesis were of the type: "can the computer more effectively or efficiently achieve the aims of the curriculum?", for example, "does a drill-and-practice computer program more efficiently or effectively get the pupils to learn their arithmetic-tables?" then it would clearly have been appropriate to use such a research method. Following this method would have required pupils to be pre-tested and divided into two matched groups. One group (the experimental) could have been taught their tables using the computer program, and the other group (the control) could have been taught in the standard way. Finally a post-test could have been administered, and the (numerical) results would show which method had been the more effective.

As Parlett and Hamilton (1972) explain, with this research method:-

> "Students - rather like plant crops - are given pretests (the seedlings are weighed or measured) and then submitted to different experiences (treatment conditions). Subsequently, after a period of time, their attainment (growth or yield) is measured to indicate the relative efficiency of the methods (fertilizers) used." (Quoted in Curriculum Evaluation, Hamilton, D., 1976, p13).

The scientific method of educational research has been criticized on a number of methodological and philosophical grounds (for example, Hamilton 1976). The basic criticisms relate to the inherent views of knowledge, objectivity and truth, which, on educational grounds, are considered unrealistic and irrelevant. One of the supposed arguments for the positivist position is its claim to value-freedom. But herein lies a source of objection for, as Kuhn (1970) has argued, the development of scientific knowledge is not divorced from subjective values. Scientific knowledge develops through a succession of "revolutions" in which the current dominant paradigm, or way of looking at problems, is overthrown and replaced. And all paradigms, including the scientific, have underlying assumptions which cannot be divorced from judgements of value.

On the basis of scientific research into educational situations, it is claimed that objective decisions may be made regarding the best course of action. But the research questions asked can only concern "means" since the "ends" themselves are value-laiden. So, a major criticism of this approach to educational research is that the ends themselves remain unconsidered; the educational value of the aim of the "treatment" in the pre-test, post-test example, is accepted without question. In addition, questions about "means" are also value-laiden since they cannot be solely assessed in terms of their instrumental value; "means" also incorporate attitudes towards people (here, teachers and pupils). For example, the best, as in the sense of the most efficient or effective means to get pupils to learn certain grammatical rules might be to deny them their school lunches until they have successfully completed the exercise. But even the scientific researcher is likely to find such means objectional. Hence, assessing means alone is not value-free either. Any assessment of means in educational settings is always open to question on both instrumental and moral grounds.

A further criticism of the positivist approach regards the relationship between means and ends it embodies. Means and ends, for the scientific reseacher, are divorced, yet, they are clearly inextricably linked, as earlier parts of this thesis have shown. Put simply, ends determine what is to count as an education process. Empirical educational research is severely limited if construed in scientific terms, for then only questions relating to efficiency or effectiveness of means could be studied. Such criticisms were also made of the means-ends objectives model of evaluation.

The instrumental and simplistic view of the nature of education makes the positivistic approach and the scientific methodology it endorses inappropriate for examining the quality of educational processes. The claim of scientific objectivity is in fact a source of weakness, for, in so doing, a simplistic, mechanical view of human action is endorsed. As a result, the crucial importance of subjects' own interpretations of events are either neglected or ignored. By attempting to "control variables" in a scientific fashion, the researcher is likely to end up with:-

> "a pruned, synthetic version of the whole, a constructed play of puppets in a restricted environment."
> (Shipman, 1973, cited in Cohen and Manion, 1980, p23).

4.1.2 The Interpretive Research Paradigm.

The alternative educational research paradigm may be termed the "interpretive". This approach builds on the considered failure of the scientific approach to accept and study mankind as s/he actually is. It is a move away from the psyco-statistical paradigm. The interpretive paradigm recognizes that educational research is different from scientific research, just as educational theory is different from scientific theory; whereas scientific theory and research is descriptive and explanatory, educational theory and research is intended to guide practice and is therefore prescriptive (see references to Frankena and Peters in Chapter Two). The interpretive paradigm supports an anthropomorphic model of man, and adopts ethnogenic, rather than scientific methods of investigation. The interpretive approach:-

> "concentrates upon the ways in which a person construes his social world. By probing his accounts of his actions, it endeavours to come up with an understanding of what that person was doing in the particular episode." (Cohen and Manion, 1980, p24).

The scientific, statistical-experimental paradigm holds the assumption that evidence for educational research is in terms of behaviour, and that a major concern of research is the prediction of behaviour in response to particular stimuli. The interpretive paradigm questions the adoption of the behaviourist model and recognizes instead the importance of the participants' meanings and interpretations of events, and not simply their on-the-spot behaviour.

Since, for the interpretive researcher, understanding is the centre of attention, the data gathered is qualitative - subjective, interpretive, internal and unique. And since the researcher values the subjects' own interpretations, it follows that his/her role is much more involved and participatory.

The interpretive paradigm can be seen to support the process model of educational evaluation as examined earlier. The interpretive paradigm and the process model of evaluation both share an awareness of values and an understanding that means and ends are inextricably linked.

Just as the scientific paradigm implied certain methodologies, the interpretive approach to research also has related procedures. Willis (1981), states that such methodologies involve:-

> "the varying perceptions and meanings of all participants in the curricular process and often attempts to account for the mutual influences between a curriculum and the socio-cultural context in which it is embedded. This form includes certain common assumptions and methods which have been subsumed under a variety of names, such as 'qualitative', 'responsive' or 'illuminative' evaluation, 'educational criticism' or 'ethnography'. It attempts to discover what being in an educational situation is like, what it means to participants, how it has been influenced by external circumstances, and what the many consequences will be; it attempts to assess both the goodness and the significiance of situations and consequences." (p40).

The general term that shall be adopted here for these types of research methods is "qualitative". The qualitative, (or interpretive, or naturalistic) approach to research has emerged relatively recently. In contrast to quantitative methodology, one of the main concerns of qualitative is the uniqueness of individual settings and situations (in this case, the schools, classrooms, pupils, teachers). Rather than designing a study which encompasses a large number of schools, the qualitative researcher would study one or two in greater depth and detail, employing such techniques as observation and semi- or unstructured interviews. This approach too has underlying assumptions, one being the belief that human situations are too fluid and complex to be adequately captured by statistical analysis.

A central concern of this thesis is whether the computer can improve the quality of the educational provision of schools, rather than merely improve efficiency or effectiveness. From the theoretical analysis so far, it seems clear that a question like, "is the computer improving the quality of the educational provision?" could not be adequately addressed through a quantitative methodology alone. If the data required had been of a factual nature, questions of the type "how many microcomputers does the school have?", "what age children use the computer?" or "does the school use Logo?", then quantitative methods would be more suitable. Rather than identifying the type and frequency of computer use in primary schools, the attention of this research is directed more towards the meaning of computer education, the way in which it is interpreted by teachers in primary schools, and the extent to which it can improve the quality of their educational provision. From the examination of paradigms of educational research, it is now clear these questions can only be fully investigated by adopting an interpretive approach to research and by using research methods which are mostly qualitative rather than quantitative. This particular research uses a case study methodology. An examination of case study research together with the methods of collecting and analysing data, and arguments for, and criticisms of, the methodology, will be outlined in the following pages.

4.2 Case Study Research.

Case study research methodology has become increasingly popular in recent years. Interestingly, not long ago, it could be dismissed in three short paragraphs in an Open University course on "Methods Of Educational Enquiry" with the statement that:-

> "The simplist approach to educational research is the case study... very often case studies are not representative and hence the results apply only to that group and to the specific situation involved... Nevertheless, a case study can be a useful starting point for a piece of research; it can also be used by students to gain a flavour of research without being involved in unnecessary complications." (Entwistle, N. J., 1973, p19/20).

A fairly damning and somewhat patronizing statement. Entwistle leaves the impression that case study may be a useful and easy start to a piece of research, but that it should only be considered a preliminary to the real thing. Fortunately, this opinion has been superceded. Case study is now widely recognized as an important methodology for educational research in its own right. But what exactly is case study research?

4.2.1 Defining Case Study Research.

Several writers have offered definitions. Walker (1974) describes case study as:-

> "an examination of an instance in action." (p48).

Nisbet and Watt (1978/9) define it as:-

> "A systematic investigation of a specific instance." (p5).

And they argue that it is more than:-

> "just an extended example or an anecdote interestingly narrated." (p5).

But these statements are somewhat vacuous, and some (Atkinson and Delamont, 1981) have accepted that it is difficult to supply a hard-and-fast definition of case study. This is not surprising since the term "case study" is tied up with other terms which defy straight-forward definition, such as "ethnography" and "illuminative evaluation". To further cloud the problem, the approach employs certain methodological techniques (observation, interview, document analysis) varieties of which might not be considered strictly qualitative. Although it is usually associated with a qualitative approach to research, the methods employed need not necessarily all be qualitative. Adelman et al (1976) comment that:-

> "case study is an umbrella term for a family of research methods having in common the decision to focus an inquiry round an instance. Not surprisingly, the term 'case study' remains a slippery one." (p140).

Case study should not be straight-jacketed as a research methodology which only employs qualitative methods since more quantitative methods may also be employed in the gathering of data for the case studies. Hence, depending on the methods used, case study could be either interpretive educational research, <u>or</u> scientific educational research. Speaking of the case study method, Walker (1974) writes:-

> "Superfically case study is often set against quantitative research as belonging to a different 'paradigm', but in some ways this distinction is misleading, the case study worker is often more 'quantitative' than is realized." (p58).

It may also be worth pointing out that the quantitative and qualitative research methods used for gathering data for case study are not mutually exclusive; one type of method may be used to reinforce another, or shed a different light on the problem. Indeed, a strong case may be made for employing both quantitative and qualitative methods.

However, as far as what might count as an instance, or a case, there seems to be less doubt:-

> "The instance may be an event or a person or a group, a school or an institution, or an innovation such as a new syllabus, a new method of teaching or a new method of organization.
> (Nisbet and Watt, 1978/9, p5).

4.2.2 **Methods Of Collecting Data For Case Study.**

Although a variety of methods, both qualitative and quantitative, may be involved in the gathering of data for case studies, evidence for case study usually involves some form of observation and interview; it involves direct contact with those being studied. However, the form of observation and interview may vary from the structured, or closed interview, where both the questions and the type of response are decided upon in advance, to the unstructured, or open-ended interview, which is not rigidly preplanned. Structured and unstructured interviews are best thought of as lying at two ends of a continuum. Towards the middle is the semi-structured interview, where the reseacher often has clear ideas of the questions s/he wants to ask (an agenda of topics), but at the same time is flexible enough to pursue side issues, which may in themselves provide useful evidence. The researcher is often faced with the problem of deciding how far s/he listens or how far s/he interrogates. Generally speaking, the more ethnographic and qualitative the researcher, the less structured and directed the interviews.

Interviews may be recorded in different ways. Sometimes audio- and/or visual-recordings, supplemented by notes made at the time, are used. Sometimes, particularly with an unstructured interview, such intervention is inappropriate and creates a more formal atmosphere. In such cases it maybe more suitable to make notes as soon after as possible.

Observation techniques can also vary from the unstructured to the much more structured "systematic observation" which involves a check-list of behaviours that are recorded at a set time period. On the other hand, "participant observation", as its name suggests, involves the observer taking part in the activities s/he has set out to observe. For example, a researcher investigating the effects of membership to a Hell's Angels chapter, may engage in participant observation by becoming a member him- (or exceptionally in this example) herself. If his "cover" is complete, the other members of the gang will accept the researcher as one of their own. The belief is that one can only truly understand the group if one fully "participates" as a member.

Given this, it is hardly surprising that one of the major drawbacks of participant observation is that it can often involve deceit and the breaking of confidences, which may be criticized on ethical grounds.

With non-participant observation, the researcher remains "outside" and does not participate; those being studied are aware of the researcher and his/her broad intentions. One of the suggested criticisms of this method is that the non-participant observer may have a distorting effect on the activity under observation. A strange person sitting at the back of the classroom may cause both the teacher and the pupils to behave in an atypical fashion. However, a good participant observer should not have this effect.

For recording observation data, fieldnotes often form the main technique. Notes may be made either at the scene (these may take the form of a structured observation schedule), or directly after (perhaps taking the form of a research journal). Photographs may sometimes be taken too, or even a video film.

Interviewing and observation are usually the main methods of gathering data for a case study, but document analysis can also provide useful information. Documents may take the form of, for example, school curriculum statements, news letters sent to parents, children's work, and minutes from meetings.

When the researcher has spent an considerable time in the field, a large amount of data will have accumulated. Before any case study report can be assembled, the data needs to be carefully scrutinized and analysed, if the rewards of the fieldwork are to be reaped.

4.2.3 Analysing Case Study Data.

Any academic research should meet scholarly standards. But the researcher working within the interpretive paradigm has to face the problem that these "standards" are not particularly clear. Within the normative paradigm, the standards governing experimental research are much more clearly established. With case study research, the methods used to analyse the data are central to its ability to stand up to critical scrutiny.

Stenhouse (1978) has written on this and suggests that case study organisation is considered in three stages, namely, the "case data", the "case record" and the "case study". The introduction of the Case Record stage is of central importance; this is the intermediate stage between the gathering of data (fieldwork) and the writing up of the case study. The Case Record he describes as:-

> "a... condensation of the case data, produced by selective editing without explicit comment..." to "be regarded as an edited primary source". (Stenhouse, 1978, p37).

And Stenhouse further argues that this Case Record should be made publically available. In this way the empirical research is open to scruntiny. Raw fieldwork data is most usually in a form that is not at all easily open to critical scruntiny; the raw data is likely to contain some irrelevant material, long hand-written accounts and untranscribed tapes, and most of this will not have been organized in any logical fashion. Such a mass of raw data hardly encourages critical scruntiny.

The preparation of such a case record involves several stages, not least of which is the collating and sifting of data from all sources, the seeking out and distinguishing between relevant and irrelevant material, and the careful organizing and coding of the former. However, once the Case Record has been established, the process of writing the case studies is less difficult.

Once a draft case study has been completed, a good researcher will clear it with the key participants. This "practice of negotiation" requires the researcher to show the draft copy of the report to those s/he has studied. This gives those under investigation the opportunity to amend statements they have made, change emphasis and clarify. For example, a case study of a particular school may involve interviews with the Headteacher, and his/her opinions may be revealed in the report: the practice of negotiation gives the Head the chance to check what is being said, and perhaps to make changes, before the write-up is printed.

Although this is generally accepted as good practice, problems can arise if the researcher presents a particular case in an apparently negative light, even though this may truly reflect the situation that has been observed. How does the researcher cope with the Headteacher, who for instance, on being shown a draft report, wishes to make changes in order that s/he may be presented in a more favourable light? In addition, opinions may have changed between the time of the research and the draft report; making changes at a later date may affect the original research.

The practice of negotiation could at times lead to unnecessary complications, and providing those involved have been made annoymous, the practice may be considered non-essential. The development of a case record is more important since it renders the case study research more open to critical assessment. It is obviously important that empirical research is open to criticism for in so doing it might be seen to meet academic standards. But there are those who argue that even doing this will not turn case study into a rigorous research methodology. Such criticisms are addressed in a later section. First, arguments put forward for using the case study approach are considered.

4.2.4 The Case For Case Study Research.

The growing interest in case study research and other generally qualitative methods, partly stems from a reaction against the traditional normative paradigm of educational research and its related quantitative methods. Justification for case study research has been suggested on basically two different grounds: some advocates justify this approach by criticizing more traditional approaches, (a "reactionary posture"), whereas others offer a more positive justification (a "progressive posture"). Kenny and Grotelueschen (1984) have defined four strategies for making the case for case studies, (two reactionary, two progressive).

The first of these strategies is to criticize traditional educational research (a reactionary posture). For example, comparing case study with the systematic techniques of the survey, Nisbet and Watt (1978/9) comment on the latter:-

> "it may obliterate the unique features and problems with small groups, or even within an institution or an individual... which may hold the key to the puzzle... The researcher finds only what he seeks: if something is not covered in the survey instruments, it will be missed." (p8).

Kenny and Grotelueschen (1984) point out that the problem here is that, although there may exist strong arguments against traditional research methods, support <u>for</u> case studies cannot be gained from dissatisfaction with other methods alone. This may be true, yet arguments against one approach can lend support for an alternative.

The second strategy is to compare approaches to methodology (another reactionary posture). Here it is not argued that traditional research methodology is always unsuitable, rather that case study methods are more appropriate to <u>educational</u> research. For instance, using this strategy, Holt (1985) in a review of "The Research Process In Educational Settings: Ten Case Studies" (Burgess, editor, 1984) writes:-

> "Quantitative research in the social sciences can be seriously misleading: qualitative researchers - inasmuch as they live with uncertainities - may be less likely to take us far from the truth." (p362).

Kenny and Grotelueschen (1984) suggest that the appropriateness of the methodology could be discovered by comparing different approaches on the same grounds and seeing which is the most useful or successful. However, they point out that this strategy is self-contradictory since traditional research methods could be used to show that case study was more appropriate than traditional research methods!

The third strategy, as explained by Kenny and Grotelueschen, is more complex. Those who attempt to justify the case study approach using this strategy argue that, of the three major philosophical theories of truth, (correspondence theory, coherence theory, and pragmatic theory) case study tends to lean towards coherence theory, whereas theoretical science and traditional research lean toward correspondence theory, concerned with appeals to facts. Coherence theory, on the other hand, allows for inconsistencies in people's interpretations of educational phenomena, as long as they hang together. Alternatively, the pragmatic theory of truth may be used to justify case study. Kenny and Grotelueschen explain that:-

> "the pragmatic theory of truth is built upon the criterion of workability. A theory is true to the extent that it guides action successfully." (p47)

And they argue that this could provide a fresh and promising justification for case study.

The fourth strategy involves an historical approach (a progressive posture) which pays attention to the political problem of promoting the academic respectability of case study. The possibility of basing case study on a model of historical documentation, interpretation and explanation is raised.

Although the case study approach has its critics, its advocates claim that is it both justifiable, and particularly useful in the social sciences. Case study research, by its openness and flexibility, can overcome many of the problems associated with purely quantitative research methods. The importance of unique features is recognized, and behaviour is not straight-jacketed into pre-defined categories. Adelman et al (1976) write of case studies:-

> "Their peculiar strength lies in their attention to the subtlety and complexity of the case in its own right." (p148).

These are the main strengths case study methodology. Such strengths are examined further when the suitability of using case study in this research is considered in section 4.3.2. But first, the major criticisms are reviewed and addressed in the following section.

4.2.5 **Criticisms Of Case Study Research.**

The main arguments against case study research stem from concerns about reliability, validity and generalizability. As Walker (1974) writes:-

> "The objection most often raised to case study is the 'generalization problem'. This is seen in terms of the limited reliability and validity of the case study...." (p49).

The <u>reliability</u> of case study research has been questioned. For research to be reliable, another researcher entering the same situation, using the same methodology, would obtain similar results, i.e.:-

> "Given high reliability, it should be routine for other researchers to reach the same representations from the same events." (Walker, 1974, p59).

Critics of case study research doubt its reliability. For example, Shipman, (1973) argues that techniques such as observation and interviewing are never completely reliable since there is always opportunity for distortion through the investigator and his/her interaction with the subjects of the study. Here one embarks upon the question of subjectivity. Reports of occurrences in the classroom may vary greatly depending on the interests and background of the researcher: a teacher, a parent, a psychologist, a sociologist, or an economist may observe classrooms and what goes on in them, in differing lights; they may emphasize different activities and events. Shipman (1973) states:-

"Impressions are first selected and then interpreted within the mind of the observer. Between the impression on the senses and the reported interpretation are the attitudes, values and prejudices, as well as the academic conceptual models, of the researcher." (p75).

Likewise, Nisbet and Watt (1978/9) comment:-

"we cannot tell how the observer's perception has affected the conclusions reached." (p8).

Case studies have been criticized for being subjective, but it might also be asked if other research methodology is so non-subjective: statistical analyses of research data are claimed to be more objective, yet both the choice of hypothesis and interpretation of data and results is selective and subjective. Is it possible for any research to be completely objective, particularly that which deals with people? Case studies, although to an extent subjective, may also be rigorous and far from arbitrary descriptions of events.

A consideration of objectivity also involves the question of validity. Do case studies truly reflect the reality under investigation? Has there been a failure to observe what the researcher claims to have observed? Cohen and Manion (1980) argue that case studies need to be valid both internally and externally. The critics of internal validity suggest that since no researcher may enter with an empty head, his/her inevitable presuppositions, and close involvement, will distort the findings. Cohen and Manion (1980) also note that accounts of observation (particularly of the participant kind) have been criticized as subjective, biased and impressionistic. How can one tell the report represents the real picture?

To counteract the general challenge of validity, those employed in case study research tend to make use of two or more methods of data collection. This is known as triangulation. If it can be said that data from more than one method relates to the case in a similar way, then there is evidence to suggest that the research is valid. Cohen and Manion (1980) comment:-

> "...triangular techniques in the social sciences attempt to map out, or explain more fully, the richness and complexity of human behaviour by studying it from more than one standpoint and in doing so, by making use of both quantitative and qualitative data." (p208).

In this research, alongside the usual methods for collecting evidence for case study (observation, interview) an attitude scale was used.

Critics of case study question the extent to which the findings of the research can be generalized. Results from investigations in any one school, at any one time, may not be applicable to others. It is suggested that the teachers and the pupils in their schools are too complex and unique, and that consequently, the results of case study research may not be generalized (and yet the complexity of the educational situation is claimed to be one reason for using case study). If research findings on the small scale cannot be generalized to the wider field, what relevance or point is there to the investigation? This criticism amounts to a most serious attack on the use of this method of research. However, advocates of the qualitative approach to research recognize the importance of the uniqueness of the individual or situation, and believe that case studies (which analytically interpret the evidence) may go a long way towards understanding situations, by reflection.

It may also be questioned whether case study advocates should meet the challenges of generalizability, validity, reliability and objectivity. It is not an aspiration of the case study researcher to produce generalizable data; rather, the onus is often on the reader to decide the extent to which the situation applies to their own. Moveover, Kenny and Grotelueschen (1984) argue that:-

> "it is inappropriate to try to answer all of them (the criticisms), because they use concepts which belong to quantitative research and positivistic traditions. As a result, case-study advocates are in yet another problematic situation: they are trying to build a case for an alternative approach to educational research and evaluation with the language and criteria of the more traditional approach." (p44/5).

Although case study research has its critics, it appeared the most appropriate approach for this investigation. The third part of this chapter examines the aims and the methodological decisions of this research.

4.3 Case Study And This Research.

4.3.1 The Focus Of The Case Study Research.

The main purpose of the case study research is to pursue empirically the questions raised and examined in the first, theoretical, part of the thesis. How are schools interpreting computer education? How are microcomputers affecting the curriculum, the role of the teacher, and the pupils? To what extent is the computer being used to enrich educational processes rather than merely improve the efficiency or effectiveness of the achievement of the existing curriculum goals? Is the computer being used in practice to mechanically translate current provision, or is it (and if so, how is it) being used to promote the development of educational processes in primary schools? The focus of the empirical research is not on the type and frequency of computer use. Rather, attention is directed more towards the meaning of computer education and the extent to which it is improving the quality of education provided by primary schools. It is hoped that the case studies will illustrate interpretations of computer education as realized by different primary schools.

4.3.2 The Suitability Of Case Study Research.

Users of computer software may have different ideas and intentions from those held by the designers; it is possible to use programs in ways the designers had not intended, so creating different implications for practice. What Atkinson and Delamont (1981) say in their explanation of case study usefully shows the appropriateness of the case study method for this researcher:-

> "In general terms, the approach rests on the belief that the innovation to be examined cannot be treated simply as a set of objectives, or as a variable or variables to be measured. Innovations 'on paper' maybe transformed radically, in the course of their actual implementation. The reality to be investigated then, is a complex social reality of everyday life in institutional settings. The emphasis is firmly - even exclusively - on process rather than 'product' or outcomes." (p27).

Speaking of innovation in general, Parlett and Hamilton (1976), propose the analogy of the theatre, which seems relevant to this research. They suggest that if one is assessing a play for the theatre it is insufficient simply to study the text; it must also be seen in action, i.e. the performance, since actors and director may interpret it differently. And, just as there is no play that is "director-proof", so too there is no innovation that is "teacher-, or student-proof". Parlett and Hamilton (1976) continue:-

"If this is acknowledged, it becomes imperative to study an innovation through the medium of its performance and to adopt a research style and methodology that is appropriate. This involves the investigator leaving his office and computer printout to spend substantial periods in the field. The crucial figure in the working of an innovation - learners and teachers - become his chief preoccupation." (p227).

It would have been quite possible, and not particularly difficult, in this research to have examined available software for primary schools and assessed its educational significance and value. To have done this alone would however, have failed to take into account two important features of educational settings, namely what Parlett and Hamilton (1976) call the "Instructional System" and the "Learning Milieu".

The Instructional System consists of the blueprint, or the objectives and desired outcomes of an innovation. For instance, in the case of a piece of software, the instructional system would consist of the materials themselves, and instructions and documentation, the recommended approach, aims and objectives, claims for its utility, i.e. the "official" view of the purpose and use of the software. Parlett and Hamilton explain that a traditional evaluator is prone to ignore the important fact that the instructional system always has to be interpreted, and always will be interpreted, differently by different people in different situations. The traditional evaluator simply:-

"examines the blueprint or formalized plan and extracts the project's goals, objectives or desired outcomes. From these in turn, he derives the tests and attitude inventories he will administer. His aim is to evaluate the instructional system by examining whether, for example, it has 'attained its objectives' or met its 'performance criteria'". (Parlett and Hamilton, 1976, p216).

And in doing this, the traditional evaluator fails to realize that the instructional system, when taken on:-

"undergoes modifications that are rarely trivial... It assumes a different form in every situation. Its constituent elements are emphasized or de-emphasized, expanded or truncated, as teachers, administrators, technicians and students interpret and re-interpret the instructional system for their particular system." (p216/7).

This is an important point and highly relevant to this research, and adds strength to the argument that a case study methodology should be used so that computer use is not only seen in terms of the official "instructional system" but also, and crucially, in <u>action</u>.

Traditional research and evaluation methodologies also ignore the "<u>Learning Milieu</u>", that is:-

"a network or nexus of cultural, social, institutional and psychological variables. These interact in complicated ways to produce, in each class or course, a unique pattern of circumstances, pressures, customs, opinions and workstyles which suffuse the teaching and learning that occur there." (Parlett and Hamilton, 1976, p217).

In other words, by failing to study in any depth particular settings and situations in which the innovation is employed, traditional research ignores the influence of a number of constraints (financial, organizational, administrative) and variables (teaching style and methods, student perspectives). The learning milieu is another argument for a more qualitative methodological approach. Indeed, Parlett and Hamilton (1976) conclude:-

"Acknowledging the diversity and complexity of learning milieux is an essential pre-requisite for the serious study of educational innovations." (p217).

Not only does it seem that the research questions posed in this thesis are of a type which warrant a small-scale indepth study of a few schools, and that the theoretical study indicates a qualitative research methodology, but also that, in order to evaluate computer education and its potential to improve the quality of the curriculum, it is necessary for the researcher to go into schools and see computer programs used in action; to uncover the educational values or purposes being pursued and to discover whether they are adequate or insufficient. The case study approach to research seems particularly appropriate to this task. "Computer education" (like most innovations) is not a straight-forward business and, as has already been seen, the term can be interpreted in different ways. In order to grasp and go some way towards understanding the inherent complexities of computer education, the case study approach was employed.

This research is based on three primary schools and the approach each took to computer education. For each school, the purpose of the study was to investigate the use of the computer and the consequential interpretation of "computer education" adopted. The case studies then are essentially of computer uses and interpretations (rather than studies of schools).

4.3.3 **The Case Study Schools.**

The schools for the case studies needed to be chosen so as the diverse use of computers in primary education and consequently, the different interpretations of computer education, could be reflected. In the event, the schools (anonymized as Longsight, Ben Mercy and Headland were selected because it was believed that they exhibited such differences. All are County primary schools located on Anglesey. Each caters for the children aged 4 - 11 in the locality, and in each case the schooling is bilingual and co-educational.

Headland school lies on the outskirts of a sizable town and has 217 pupils on roll, a number of these coming from rather less-advantaged homes. There are seven teachers, a nursery assistant and Headteacher. The school is of open-planned design with four distinct units: units 1 and 2 for 4 to 7 year olds; unit 3 for 7 to 9 year olds and unit 4 for 9 to 11 year olds (HDocInP1){1}. The classes are taught in ability groups (despite anticipations to the contrary based on the design of the buildings) and each group consists of up to eight children.

From the Information For Parents document, it is stated that:-

> "The function of the school is to foster and encourage the child's development as an individual and as a member of society. A thorough grounding in the basic skills is emphasized but regular class and group projects help originality and the development of the particular interests of each child." (HDocInP1){1}.

The curriculum is thought to foster this general aim by developing the basic skills (listening, speaking, reading, writing and mathematical skills), studying and interpreting the environment, encouraging a healthy social attitude and enabling pupils to give expression to a variety of experiences. Language, mathematics, science, environmental studies and religious education are studied along with music, physical education, sports and art and craft work. No written policy statement about computer education has been made, but, to put it briefly, Headland school used the computer for simple drill-and-practice programs, most of which came with the Introductory M.E.P. Pack (and in this sense, of the three schools, Headland was the most typical).

Ben Mercy school is situated in a seaside town on Anglesey. It was opened in 1969 and has in the region of 210 to 250 pupils on roll (the numbers have fallen in recent years, from 240 in 1984/5 to 217 in 1985/6) and 11 members of staff (including Head and Nursery Assistant). A number of the children have monolingual English parents. Unlike Headland, this school is not of an open-planned design, although it should not be concluded that the buildings reflect a formal approach to the teaching style. By and large, the stated function of the school (BDocPr6){1} is the same as most other schools in the County (i.e., it aims to foster and encourage each child as an individual and as a member of society). Additionally, the school recognises that some pupils do not have the security of a loving and complete family unit (because of the breakdown of marriages and so on) and consequently the school feels it important to teach children to think for themselves, and also provide a good family atmosphere (BDocPr){1}. The curriculum is likewise broadly similar to other schools' (developing basic skills, studying the environment, providing varied experiences and opportunity to give expression to them). The approach to the teaching of this curriculum is outlined in the school prespectus:-

> "In the Junior department, the 'core curriculum' (language and mathematics) is taught formally to a large extent, as are music and scripture. The majority of formal teaching takes place during the morning session, while the afternoon session is largely given over to teaching through the medium of a co-ordinated project."
> (BDocPr6){1}.

The entire Junior department work on a project with a common theme for about one term (past projects have been on travel, food and colours). The school prospectus states that this provides an opportunity to work across the curriculum, including some practical aspects of the "core curriculum", and the intention of this approach is:-

> "to develop skills, such as researching and problem solving, and it helps to place the pupils' formal work in the context of the real world of which they are part. We see the computer as an important and effective tool in this approach." (BDocPr6){1}

Ben Mercy school has a clear curriculum arrangement with a balanced emphasis on the formal teaching of basic skills and the integrated project work approach. Importantly also, this school recognizes the computer as a useful curriculum tool. Further, from conversation with the Headteacher, it seems that the present curriculum arrangement (formal teaching in the morning; project work in the afternoon) has been influenced by the use of the microcomputer. Following the Headteacher's secondment year (1984/5), during which time study for an M.Ed. was undertaken, the project work was introduced. The Headteacher's M.Ed. study centred on the application of the computer adventure similation program "Adventure Island". From this work, he discovered that "kids weren't good at using their nouse" (Bf3){1}. They were not used to "following their noses", largely because of a formal style of teaching. He felt that the pupils might have been better at "Adventure Island" if they had been accustomed to finding out things for themselves (Bf{J85}4){1}. It was anticipated that the project work approach would encourage pupils to "think for themselves rather than be spoon-fed" (Bf3){1}.

Simply because of the variety of computer uses, (including some instructional programs, adventure programs and data processing) Ben Mercy school was very different from Headland. At this school, a different interpretation of computer education was employed.

Longsight like Ben Mercy is located in a coastal town on Anglesey. It is a sizable school with 172 pupils and has suffered from falling rolls resulting in a school building with ample space for the present numbers. There are indeed two free classrooms, one of which is used as a library. Rather than being open-planned, the classes each have separate rooms, all the Junior classrooms leading off one long, airy corridor. The teaching style varies according to each teacher and cannot be straight-forwardly classified as either progressive or traditional. The pupils attending the school are generally first language English speakers. The school exudes a busy and lively atmosphere and the staff, (seven in number, including the Headteacher) seem good humoured and enthusiastic (although the 1985/6 Industrial Action lowered morale).

Each member of staff has a copy of the aims and curriculum objectives compiled by the Headteacher. This curriculum policy document is sizable and includes the clearly stated eight aims of the school. These are as follows:-

(1) To help children develop lively enquiring minds giving them the ability to question and to argue rationally, and to apply themselves to tasks.

(2) To instill respect for moral values, for other people and for oneself, and tolerance of other races, religions and ways of life.

(3) To help children understand the world in which we live, and the interdependence of nations.

(4) To help children to use language effectively and imaginatively in reading, writing and speaking.

(5) To provide a basis of mathematical, scientific and technical knowledge, enabling boys and girls to learn the essential skills needed in a fast changing society.

(6) To help children appreciate how the nation earns and maintains its standard of living and properly to esteem the essential role of industry and commerce in this process.

(7) To teach children about human achievement and aspirations in the arts and sciences, in religion and in the search for a more just social order.

(8) To encourage and foster the development of the children whose social or environmental disadvantages cripple their capacity to learn if necessary by making additional resources available to them. (Lcpl/2){1}.

These are the broad general aims of the school. The aims of the different curriculum areas are then considered in the document, but above all else, numeracy and literacy skills are thought of as the most important since they form part of all learning (Lcp4){1}. No policy statement is made in this document regarding computer education, although the computer is referred to under "Resources", and certain "guided-discovery" worksheets used in the teaching of the computer language Logo are also reproduced in the file. Additionally, the importance of computer education could be recognized as part of general aim number (5).

Longsight school was something of a special case in the sense that it devoted the computers to Logo; this school had in fact been selected at an earlier date, since a particular interest of the research is the computer language Logo and a considerable period of time needed to be spent introducing a class of children to the language (as shall be explained in the case study report).

Despite certain similarities (in terms of location and general size) between the three schools, Headland, Ben Mercy and Longsight, they each applied their computer(s) in very different ways and each of the schools could be said to exemplify one of three different approaches to computer education.

Two further considerations lead to the selection of these schools: Gwynedd is a bilingual county, and some areas are more Welsh than English;

since the researcher is monolingual English, this had some bearing on the selection of case study schools. The second point is also of a factual nature; some schools could not easily be chosen to study in detail since they were not in a reasonable commuting distance from Bangor. As it turned out, all three case study schools are located on Anglesey, a fact which, in consideration of their abundant differences, usefully unites them.

Nevertheless, the extent to which these schools were the appropriate ones to select is always questionable; how representative are they of computer education in general? The very fact that they are so different from one another, and indeed unique, raises the question, "to what extent may a unique entity be representative of anything?". But, as has already been discussed, many do recognize the value of case study research which, in this instance, may go a long way to understanding the purpose of micrcomputers in primary education. And indeed, the purpose is not to be representative. Rather, the purpose is to illustrate interpretations of computer education as realised by different primary schools: it is the purpose of surveys to be representative.

The majority of the work for the case studies took place during the academic year 1985/6.

4.3.4 Methods Employed In The Collection Of Data.

Several methods of collecting evidence were employed. Observation and informal interviewing were two of the main methods used. Most of the data was substantially recorded in a research journal{2}. The research journal record was based on fieldnotes either made briefly at the scene or filled out later. The journal was used to record factual information, as well as observation notes, comments from teachers and their answers to questions. Additionally, it was used to record impressions and reflections of what was happening. Photographs were also taken to go some way towards backing-up observation.

As for interviews, the more informal, directed-conversation type were on-going and not pre-planned; these were not taped. More formal interviews were carried out with teachers and children; these were taped. Tape-recordings of children working at the computer were also made, although these did present difficulties if the computer was set up in a "busy", noisy classroom.

Various documents were also collated. These include a written statement of the aims and objectives of the curriculum and its starting points, school brochures, children's work (on paper and floppy disk) and a record of their performance on programs which lent themselves to such recording. Some content analysis of software used in the schools was also undertaken.

In addition, an attitude scale, which was subsequently factor-analysed, was presented to all the nine to eleven years olds in the three schools.

The precise methods and data collected varied between the three case study schools. Some procedures were more appropriate than others in the different situations. For instance, the relationship with teachers and pupils at the three schools varied, as did my role as observer. At Longsight school, the role was more participant since I had introduced the children to the computer language Logo. At other times in the research, the role was much less participant. Burgess, H. (1985) reports, from her experience of case study research, the need to suit the role to the style and period of the research:-

> "Although Gold (1958) outlined four 'master roles' for collecting data by participant observation: the complete participant, the complete observer, the participant as observer and the observer as participant, I found I needed to take a particular role which suited the style and period of my research." (p180/1).

When all the data had been collected, it was analysed. This research followed Stenhouse's (1975) recommendation for developing a "case record" (which can be found in the accompanying Volume). The Case Record formed the basis of the Case Study Report (Chapters Six, Seven and Eight of this thesis). However, before the case studies are reported, Chapter Five builds a picture of computer use in primary schools, on the basis of published survey reports the researcher's own visits to schools. The intention of the next chapter is to provide a context for the case studies so that the typicality of each may be assessed.

Chapter Four: Notes.

{1} (see pages 110-115) A Note On References To The Case Record.

The Case Record may be found in the accompanying Volume.
All raw data was coded. Where the code begins with the letter H, B or L the data refers respectively to Headland, Ben Mercy and Longsight.
Other letters in the code can be identified:
f indicates a fieldnote;
i indicates an interview transcript;
Doc refers to a document (for example, the school prospectus).
Data from early school visits is shown by {J85} in the code.
cp refers to a curriculum policy document.
Any digits refer to page numbers in the raw data.

Other codes should be made clear by referring to the Case Record.

{2} (see page 116) Holly, M. L., (1984) writing about Keeping A Personal - Professional Journal (Deakin University) explains its value:-

> "A journal is not merely a flow of impressions, it is impressions plus descriptions of circumstances, others, the self, motives, thoughts, and feelings... It can be used as a tool for analysis and introspection. It is a chronicle of events as they happened, a dialogue with the facts (objective) and interpretations (subjective)... It is an awareness of the difference between facts and interpretations." (p3).

Chapter Five: A CONTEXT FOR THE CASE STUDIES.

Microcomputer use in the three case study schools is more usefully understood if examined against a broad background picture of computer use in primary schools in England, Scotland, Wales and the county of Gwynedd in particular. For this, the first part of Chapter Five examines relevant surveys and reports. The second part looks at the county of Gwynedd in particular and includes a report of visits made to a selection of primary schools in the county. This information should help provide a context for the case studies, allowing the reader to assess for him/herself the extent to which the case study schools and their use of the computer are representative of what goes on in other schools.

5.1 Microcomputers In Primary Schools: A Picture From Survey Reports.

The purpose of this section is to provide a basic history of the growth of microcomputers in primary schools. At the beginning of the decade, it was found that only 30 primary schools in England and Wales were using microcomputers (Jones, 1980). But during the period Autumn 1982 to Spring 1985 this picture radically transformed, resulting in the current situation in which almost all primary schools have at least one microcomputer. This transformation was largely the result of the Department of Trade and Industry (D.T.I.) match-funding scheme whereby, for every pound the schools raised, the D.T.I. matched it, so enabling schools to receive a half-price microcomputer system. This hardware initiative was backed up, in England and Wales, by the Microelectronics Education Programme (M.E.P.) which ran from November 1980 to March 1986.

In the early stages, M.E.P. developed a "Micro-Primer" software package consisting of suggestions for micro use and 33 short programs on cassette tape. Typically, in the period Autumn 1982 to January 1985, primary schools received a microcomputer system (most often a BBC Model B, colour monitor and cassette-tape player), the "Micro-Primer" pack and the BBC "Welcome" package.

A number of surveys have been conducted which provide some sort of picture of hardware provision and software use. One such survey was carried out during the Summer term 1985 on a representative sample of primary schools in England, Wales and Scotland, by the Reading and Language Information Centre at the University of Reading. The Interim Report (The Use Of Microcomputers In Primary Schools, Bleach, P., 1986), reveals that 93% of the schools replying to the postal questionnaire, (536 schools) had at least one computer. There was a 77% response rate which is unusually high; the author suggests that this indicates the considerable interest in the area. The largest percentage of schools had just one micro (55.04%), but a considerable number had two (21.83%). The findings also reveal the impact of the Government match-funding scheme, for (approximately) 10% of schools acquired their computer(s) before 1983, 34% during 1983, 39% in 1984 and a further 5% in 1985. Indeed, 77% of all computers were purchased as a result of the Government scheme, and 76% of all microcomputers were BBC machines. What is rather less expected is the finding that 64% of all machines had disk-drives, by Summer 1985, despite initially receiving a cassette-player under the match-funding. As for peripheral devices, the Reading researchers discovered 24.6% of schools had a printer. Other notable devices included

Bigtrak (22.4%), concept keyboard (8.6%), and turtle (7.1%).

Staff's computer awareness was found to vary. Although 67% of schools had a teacher specifically in charge of computer awareness, only 16% of schools said that all their staff were familiar and confident with using computers. In relation to this, although the Government required two members of staff from each school to attend two training sessions, 13% of schools reported that they had not had this training. But of those that had, it seemed that the courses usually only acquainted the teachers with setting up and running simple software on the machines. And 64% of schools had received no further training.

As for software, 83% of the schools had the M.E.P. "Micro-Primer" software. Apart from this, use of other programs varied tremendously, with 32% of schools having less than 10 other programs.

These researchers (1986) concluded that the findings indicate that:-

> "schools in general are only very slowly absorbing computers into the curricula..., a staggering 64% (of staff) were left in the position of only being able to wire up and run their machines.... If staff were not receiving enough help initially, it is not surprising that so many had not moved beyond the MEP Micro-Primer packs." (p10).

The report ends with the recognition that what is needed is a massive resource injection for in-service training and the provision of information about educational uses of worthwhile software. These recommendations are not elaborated upon in this short report, unfortunately.

An examination of that report provides a cross-country outline of computer provision and use in primary schools in the Summer of 1985. From other reports, the indications are that Wales, in particular, progressed in the early stages, in a similar fashion. In June 1984, 45 primary schools in Wales (including four in Gwynedd) were visited by six H.M.I.s (<u>Computers In Learning - A Survey Of Current Provision And Practice In A Selection Of Primary Schools In Wales</u>, Welsh Office, 1984). Although this survey was carried out in the year prior to the Reading research, the anticipations are that their findings could be similar since the Welsh survey was not of a representative sample. Rather the schools visited were ones known to be using microcomputers in a significant manner.

For hardware, this hypothesis seems to hold true. Most of the surveyed schools, (31 out of 45) had obtained their machines in 1983, and all had acquired them through the match-funding scheme. A lot of the schools (23 out of 45) had just the one micro, though 94 machines in total were found in the 45 schools (an average of just over two per school). As for peripherals, once again, the most common choice was a printer (9 schools), 8 had Bigtrak, and 2 concept keyboards. The number of programs, (including the M.E.P. "Micro-Primer" package and the BBC "Welcome" pack) varied between 30 and 300.

The H.M.I.s identified five main areas of computer application and found that all 45 schools used structured reinforcement programs (drill-and-practice programs largely dealing with exercises in number); 39 schools used simulations; 23 fact-handling (including such programs as "Factfile", "Quest", "Viewfile" and "Quizfile"); 11 Logo and 5 word processing ("Edword", "Primary Pen", "Merlin", "Scribe" and "Wordwise"). Two schools claimed to apply the computer in <u>all</u> these areas, whereas three schools just used structured reinforcement programs. (Here it should be remembered that these 45 schools were chosen for their significant use of computer(s)). As an aside, one somewhat surprising finding is that although 9 schools had printers, only 5 schools were using word processing programs. Although printers can be used for other things (screen dumping Logo designs or printing graphs of data) one obvious use for the printer is in conjunction with word processing, thus it is a little surprising that not all those with a printer used word processing packages.

The Welsh survey also reported that, in most schools, computing had been timetabled, but the majority of pupils have less than half-an-hour per week, and with block timetabling, many pupils spend much of this time re-learning. The most common way this time had been organized was in small pupil groups with 2 to 4 pupils in each. The H.M.I.s also found that more than 80% of the schools located the micro in ordinary classrooms (or home-bases in open-planned schools), although there were instances where the computer was set up in spare rooms or libraries, and in one case, a large store room.

More than half the schools (25) made the computer available to all aged pupils, although some restricted use to Junior aged pupils, and a minority to Upper Juniors.

Hence, in summary, typically pupils were found working at the computer in small groups for less than half-an-hour per week. And during this short time, the teachers were:-

> "generally not teaching their pupils about computers but are using computers to help children learn other subjects. In only a small minority of schools visited is the aim to acquire computer knowledge, including the ability to program. Most primary schools emphasize what they term as 'basic skills'."
> (Welsh Office, 1984, p14).

To some extent these observations conflict with some other findings

(Jackson, Fletcher and Messer, 1986). Other researchers have found that one of the major advantages of using computers, voiced by teachers, is that "children become familiar with them" whereas, as the above comment suggests, only a minority of teachers are concerned with increasing their pupils' computer knowledge. However, the term "computer knowledge" is ambiguous in this context.

The reported emphasis on "basic skills" is apparent, for no less than 43 out of the 45 schools used the micro in teaching mathematics and number work. Similarily, 41 schools used the micro in language work (especially in spelling, formal aspects of grammar, but in imaginative work too). 12 schools also used the micro in science lessons; 5 for environmental studies; 20 in humanities and topic work (including geography and history); 5 in music; 2 in religious education and 2 in art. Hence, despite a concentration on basic skills, the micro was found to be applied in other areas of the curriculum. The H.M.I.s comment that:-

> "the best work seen is from programs which integrate into the general curriculum, mainly simulations and database programs." (p26).

However, although there was some evidence of integration of microcomputer use across the curriculum, the H.M.I.s also report that schools generally have <u>not</u> modified their syllabuses or schemes of work (p14). In relation to this, it was found that the majority of schools do <u>not</u> have a formulated written policy statement for the use of computers in their schools (nor policies for evaluation). On the whole, schools have not planned for the introduction of computers:-

> "For most it was a case of 'Now that we have been given a microcomputer, what shall we do with it?'". (p8).

This is perhaps an unsurprising reaction from schools which have not long had a computer, and who felt that the Government offer was too good to miss, without really thinking out the implications of introducing a computer into the curriculum. The survey reports that many teachers were anxious to receive further in-service training: two of the most pressing needs recognized were for in-service training and suitable software. Indeed, it was discovered that:-

> "There are teachers using these machines at this stage who are not yet fully convinced of their value." (p16).

On the other hand, no doubt lay with the pupils: pupil response was mostly favourable; keen, enthusiastic, lively enjoyment and high motivation. However, there were occasions when the response was less than positive, but this tended to be with programs that were insufficiently challenging.

The concluding remarks of this survey run as follows:-

> "At present the majority of schools are at the early stages of development in the use of micros in the curriculum, mainly at the stage of familiarization and use in structured reinforcement of learning. However, 20 of the 45 schools visited have made the second step into integration of the work into the general curriculum though this has occurred only in some classes of these schools. Development depends not on the length of time that a school has had equipment but more on the policy, planning and strategies adopted and on knowledge of developments and support available from outside involving all members of staff." (p34).

From the Welsh Office survey it seems that by and large the Welsh primary schools made similar responses to the microcomputers as did schools across the country. A more recent survey by the Welsh Office (Welsh Education Statistics Bulletin: No.3, 1986 Survey Of Microcomputers In Schools) considered a sample of 550 primary schools (27.5% of the total number) in early 1986. Some of the main finding may be briefly summarized.

NUMBER OF SCHOOLS	PERCENTAGE
with microcomputer	93
with colour monitor	95
with disk-drive	67

The majority of the equipment was mobile between classrooms, rather than fixed in any one room.

Most full-time teachers were found to use the micro "at least once a week". 27% had attended short in-service familiarization courses.

50% of all pupils had had "hands-on" experience by the age of five. In the 10 and 11 years old classes the micros were used for 25% of the class time.

The main areas of the curriculum in which the micro was applied was still found to be maths, language and communication. However, as pupils aged, time using the computer generally increased, and with older pupils, greater emphasis was given to areas such as problem solving, word processing, databases and simulations.

It is worth examining in more detail those finding which more closely relate to the case study schools. All three case study schools have between 101 and 300 pupils. Of the schools with this number, the survey found that:-

131/283 had 1 microcomputer,

102/283 had 2 micros,

36/283 had 3 micros,

10/283 had 4 micros,

4/283 had 5 micros.

The vast majority of this sized school had one or two microcomputers.

The following table (reproduced in part from p14) is of interest:

it shows microcomputer use in primary schools:-

APPLICATIONS	8 and 9 years	10 and 11 years
Keyboard skills	5	1
Mathematics skills	46	37
Language skills	20	20
Problem solving	7	11
Word processing	3	6
Databases	2	5
Simulations	3	4
Various purposes	14	16
Total	100	100

These figures clearly show the emphasis on mathematics skills. What is alarming is that the figures also reveal that the computer is rarely used for problem solving, word processing, databases, and most surprisingly, simulations. Although it is encouraging to see that the computer is increasingly used in these ways as the children get older, these figures are particularly low when compared with those relating to mathematics skills.

Having examined surveys of microcomputer use in primary schools in England, Scotland, and Wales in particular, it might now be asked, "how typical is computer use in schools in Gwynedd?". To go some way towards answering this question, it is worth considering available information relating to other counties.

One such survey has been carried out on schools in Hertfordshire by

Jackson, Fletcher and Messer in May/June 1984. To generalize, their findings (reported in the Journal of Computer Assisted Learning, Vol.2, No.1, 1986) suggest that Hertfordshire's provision and use of micros is fairly typical (judging on the basis of the cross country surveys examined). The researchers write:-

> "In general, most schools possessed microcomputers, but children's access was limited, and it would appear that drill-and-practice type programs were most frequently used". (p45).

This survey covered 91% of the Hertfordshire primary schools (429 schools). It was found that 56% had one micro (most typically a BBC Model B), with a further 24% intending to buy one. Most (85%) of the schools with micros had owned it for less than one year. These figures seem fairly typical for the period.

Information was also provided about the different types of software employed by teachers. The figures are displayed in the table below:-

TYPE OF SOFTWARE	% OF TEACHERS
Drill-and-practice or learning reinforcement.	57
Open-ended, or child-directed (e.g. Logo, Dart).	30
Problem solving.	28
Data- or information-handling (e.g. Quest, Factfile).	13
Games	9
Other	3

These figures clearly show the emphasis on simple programs, reinforcing "basic skills". The first result is similar to the Welsh Office (1986) finding. The second figure shows a surprisingly large percentage of teachers using the micro in an open-ended or child-directed fashion: these figures were recorded as early as May/June 1984, a time when Logo (as mentioned) was not particularly well known. A further break down of this figure (30%) would be more enlightening since "open-ended" and "child-directed" may be referred to a wide variety of computer applications. The third result concerned with the application of micros in problem solving, is again surprisingly large compared with the Welsh Office (1986) finding that only 18% of teachers of children aged 8+ used computers for "problem solving". The same seems true of the "data-handling" figures. It is note worthy that word processing and simulations are not mentioned at all, although they might have been included in one of the named categories ("open-ended", "problem solving").

These figures are clearly open to interpretation. They also present quite a different picture to that portrayed by the Welsh Office figures (1986). This may be used to support a call for further research, particularly of the case study type since there is a clear need to flesh out these figures and reveal what is hidden by them. Real instances of computer use in primary schools need to be described and analysed.

To continue the examination of the Hertfordshire survey, questions were asked about the length of time pupils had using the micro: 30% of teachers reported less than 10 minutes per child/group per computer session (mostly once a week). The researchers comment that:-

> "This indicates that children have little contact with the micro computers provided despite the tremendous potential claims made for I.T. and its influence on children's education." (p50).

The Hatfield researchers report some of the most frequently voiced advantages and disadvantages of microcomputer use in schools. The advantages mentioned are as follows: "Improvement in children's motivation for work" (47%); "School work is reinforced" (42%); "Improvement in children's learning" (33%); "Children learn to interact in groups" (21%). Although it should be taken into consideration that these "advantages" were voiced in the early days of micro use in schools, clearly the computer in the first two named advantages cannot be thought of as improving the quality of educational processes as understood in this thesis. As for disadvantages, the following were listed: "Insufficient access to a microcomupter" (35%); "Poor range and quality of software" (27%); "Microcomputer distracts children from other work" (12%). The problem of a shortage of quality software may account for the apparent lack of application of the computer in the improvement of educational processes. The third disadvantage listed, seemingly indicates a failure to integrate the computer into the curriculum.

In conclusion, it may be of value to quote the final summary of this survey so that the typicality of the case study schools may be assessed at a later point:-

> "In general, microcomputers were used with groups of two or three children at a time and the groups were usually mixed in terms of ability, sex, personality, and experience. Most classes had access to the microcomputer only once a week or less and the groups of children used it for only 30 minutes or less during this session. The most frequently used software was mathematical drill and practice; ...the Headteachers reported a favourable response from their staff... The most frequently expressed aims.... were to use microcomputers to reinforce school work, and to give

> children some experience of use to prepare them for later life... the main advantages being in the reinforcement of and motivation for school work, and the ensuing familiarity with computers... Future needs identified were for better software and greater access to training courses and advisory services." (p53).

A little information may also be provided for the county of Clwyd, a neighbouring county of Gwynedd. Weston (July 1985) reports that 94% of primary schools in that county have one micro, but fewer than 10% have more than one. Virtually all schools with a micro took advantage of the D.T.I. scheme, but additionally this L.E.A. provided money for a disk-drive for all schools and 70% of the cost for concept keyboards for half the schools.

5.2 Microcomputers In Primary Schools In Gwynedd.

5.2.1 Information From Documents.

The survey Reports examined so far present a fairly consistent picture of the history of microcomputers in primary schools and an idea of the uses to which they have been put. Although such a survey has not been undertaken for Gwynedd, there is no reason to suggest that this county should be very different, and there is information presented by Gwynedd L.E.A. that tends to support this suggestion. Gwynedd is a large, though substantially rural county. It has 205 primary schools. By 1986, 183 of these had at least one microcomputer, the remaining 22 schools not having taken advantage of the Government match-funding scheme. Of these 183 schools with micros, a large number (142) had disk-drives by 1986. Regarding hardware, the Authority's policy is not to contribute financially. However, during 1986/7 12 computer Centre schools were established and these are provided with extra equipment, including printers, which are available to the circle of schools each centre serves.

Regarding software, the Authority's policy is to provide some programs (especially those in Welsh) for the price of the disks only. This is provided through the Computer Unit at Maesincla, established by the Authority in 1986 (previously it was a M.E.P. regional centre). Additionally, the Computer Unit is intended to offer advice regarding new equipment. The availability of software for primary schools is also enhanced by county licences for some programs. In this case, the county pays the software producers a fee which provides them with a licence to copy software and distribute it to schools in their Authority. The county also has a software lending library service and additional software in the centre schools. Further, the county offers reduced prices for some software, including "Edword", the Welsh version being a particular bargain. The expenditure figures, for 1986/7, on software have been broken down as follows:-

Licences	£1650
Software for Centres	£5000
County Library	£1000

These figures indicate the county's increased emphasis on the Centre schools.

The Authority also has a policy on staff development. For those schools who have not yet received any training, this is being arranged centrally through Gwynedd and Clwyd Computer Co-ordinating Committee Board. It is intended that the courses run by H.M.I.s will be supported further. The Authority also anticipates that the Computer Centre schools will play a key role in staff development. The Computer Unit has published booklets (in Welsh) relating to computers in school, for teachers.

Information regarding computers and the curriculum may be gleaned from the Authority's draft document entitled The Primary School Curriculum (1986). The document is the product of detailed discussions and close collaborations between Headteachers, teachers and the Authority's advisers and it is intended that the objectives the document establishes should be met by all schools. The Authority's concern with the new technology is evident in the second of seven "General Objectives" Gwynedd schools should fulfil; this objective is:-

> "To increase the child's knowledge and to develop his powers of reasoning in order to assist him to adapt to a rapidly changing world which has more sophisticated procedures and techniques, in particular in relation to information technology". (p2).

Other more specific objectives are listed under five subject areas, some of which involve the microcomputer. These will be considered briefly.

Under language it is commented that a computer can be beneficial in the presentation of experiences which can promote language. Computers are also seen as being able to contribute considerably to the fulfilment of the aims of mathematics:-

> "They give both teacher and child the opportunity to solve real problems with real data and can also be used to deepen a child's understanding of the nature of number when used wisely in the teaching situation". (p13).

Indeed, the Authority states that a computer, together with suitable programs should be a mathematical resource in the primary school. However, under science, the computer is not mentioned as a resource, although it could clearly be used in the fulfilment of a number of the specific objectives listed (for example, Logo or databases could be useful in objective 2.1.9: "predicting - prophesying, suggesting 'what would happen if....' on the basis of data or observations" p16). As for <u>environmental studies</u>, it is anticipated that:-

> "During the next few years there will be an extension of the influence of the microcomputer in the schools, and the programmes, if chosen wisely, have an important part to play in encouraging the child's interest and inducing him to respond intelligently and enthusiastically". (p25).

The emphasis here on the computer's ability to encourage and enthuse should be noted, since it is apparent that its potential surpasses these. The final curriculum area distinguished is <u>art</u>, but the computer is not mentioned in relation to this.

The document includes an appendix which specifically concerns the computer in the primary school. It is recommended that schools note the following aims when using the micro in school:-

(1) "As an extra instrument for the teacher's use, to introduce and strenghten skills and linguistic, mathematical and scientific concepts" In this respect, number and language games (anagrams, identifying letter shapes, guessing missing words in a sentence) are mentioned.

(2) "As a starting point for extended individual work, or group work". For example, using programs which invite creative story writing, or which motivate project work (historical or adventure programs), or in mathematics, programs which encourage theory formulation and testing.

(3) "As an information processor or data store" (including word processing).

(4) "As a machine in the child's control". For example, children can make their own simple programs, usually in BASIC, but with the development of Logo, children will be able to work creatively in geometry from an early age.

As a result of visits made to a selection of primary schools in Gwynedd, further information was gained about the use of microcomputers in the county.

5.2.2 Information From School Visits.

Before the selection of the case study schools, (Longsight, Ben Mercy and Headland) took place, visits were made to a number of other schools in the county. Following discussion with Mr. Dafydd Price, the then M.E.P. (Wales) Primary Co-ordinator (currently the Head of Gwynedd L.E.A. Computer Department for Schools at Maesincla), a list of schools, which used microcomputer(s), was obtained.

After making contact, through writing, with a number of these schools (nine), a series of visits was undertaken across the county during June/July 1985. In addition to the three schools which were selected for case study, schools were visited in Penmaenmawr, Dwyran, Penrhyndeudraeth, Trefriw, Maesgeirchen, and Llanerchymedd. Visits were also made to two secondary schools in the locality (Menai Bridge and Bangor), to broaden the general picture of microcomputer use in schools. Before these visits, a list of questions was compiled, for the purpose of guiding conversation with teachers. It covered general factual questions (name of school, number on roll, number of computers), organizational questions (distribution of the computer between classes), software (type and how it is used), and evaluation questions (teachers' opinion of the value of the computer). These were taken to the schools but were not followed closely; since less than a day was spent at each school on these visits, the constraints of time did not allow for the asking of much more than factual questions. After the visits, notes and comments were made about the schools.

The information gained in these schools provides further details about microcomputer use in primary schools in Gwynedd. The following table presents some of the basic information gathered from the primary schools visited:-

	Date of visit	Number on roll	Number of staff using micro	Age of pupils using micro	Distribution of micro	Use	Software
Sch (a)	03/6/85	not given	1	10-11	1 hour per 10+ child per wk.	Logo	Logo, MEP Pack
Sch (b)	18/6/85	60	1	9-11	20 mins per 9+ group per day	Logo	LogoChip MEP Pack Quest, Dart...
Sch (c)	19/6/85	140	All 6	All	Half a day per week per class	Back-up class work	MEP Pack
Sch (d)	26/6/85	272	Mainly teachers of 3rd & 4th yr Juniors	3rd & 4th yr Juniors	Divided between 3rd &4th years & resource room	Back-up class work or child-selected use	MEP Pack Welcome Pack, Factfile Air-traf control
Sch (e)	27/6/85	133	All 7	All	Half-day each class. 20 mins per grp.	Back-up class work - maths mostly	MEP Pack BASIC programm -ing, Doomsday
Sch (f)	01/7/85	79	2	7-11 (7-9 mostly	Divided between Juniors. 30 mins per grp.	Related to project work.	MEP Pack Flowers of Crystal

At the time, all but one of the above schools had just the one microcomputer set-up consisting of a BBC computer, colour monitor and cassette-player, although all expressed the desire to purchase a disk-drive. The other school had an additional two Spectrum machines and a disk-drive.

These initial visits proved useful in several respects; they provided some kind of picture of computer use in the county; they amounted to the first step towards a selection of case study schools; and they indicated apparently common feelings towards computers in education. To expand this latter point, teachers' desire for more money (to purchase further hardware and software) and more time (to work through software packages and attend courses) became clear. On the odd occasion, an uneasiness towards computers in education and the fear that the visit was something of an inspection, was felt. On one particular occasion it seemed as if a show had been put on for the visit; on this instance the impression that what was observed was usual was not formed. In this school, [school (c)], it was also claimed that each class had the micro for half-a-day per week, but some pupils told me it was the first time their class had used it that term. Both the Head and the Deputy teachers expressed their scepticism of microcomputers, the Head admitting that he did not really see a great deal of point in using the computer. Perhaps this is not surprising since the only software they seemed familiar with was the M.E.P. Pack, and this was being poorly applied: the 4th Year Juniors were using a time-telling program which one pupil described as "babies' work". One teacher, at school (f) commented on such drill-and-practice programs:-

> "....they may be motivating at first, but enthusiasm soon wanes".
> (f)f(J85)3

Rather than being sceptical, some teachers in school (d) expressed a dutiful attitude. It appeared that they felt that as the computer was in the school it really ought to be used.

The way the microcomputer was being used in several of the schools visited was very disappointing. The schools in which more worthwhile work was being done (using adventure games or Logo, for instance), all had teachers who were genuinely enthusiastic and interested in computers in school (indeed some were following M.Ed. courses related to micros in education). The attitude of the teachers was obviously a crucial factor affecting the application of the micro. But, it was also apparent that each individual teacher needed to have recognised the potential educational value of microcomputers if they were to be put to good use, for clearly, although micro use with one teacher in one class could be outstanding, this might not be spread through-out the whole school. This seems true of schools (a), (b) and (f), all of which have particular classes doing good computer work, and others disregarding the machine completely.

There are many questions that need to be asked about the reasons why some teachers have recognized the potential educational value of micros, and why others have not, and such questions will be considered in sections of Chapter Nine dealing with the possible future direction of computers in primary education.

It is hoped that this chapter has provided a background against which the case study schools may be examined. The information so gained may assist the reader's assessment of the typicality of each of the case study schools, the focus of the next chapters.

PART THREE:

THE CASE STUDIES.

Chapter Six: TWO SCHOOLS AND TWO APPROACHES TO COMPUTER EDUCATION.

6.1 Introduction.

This Chapter, together with Chapters Seven and Eight and a section in Chapter Nine, form the case study report. Chapter Seven reports the Logo experience at Longsight school. Chapter Eight focuses on children's responses to the computer and includes statistical analysis of an attitude scale. This Chapter concentrates on the schools Ben Mercy and Headland. It starts with a brief look at the history and organization of computer(s) in the two schools and reveals and contrasts interpretations of computer education. In considering if the computer improves the quality of educational processes, attention focuses on whether there is a correspondence or discrepency between the type of software used (and its official purpose) and the purposes and intentions of the teachers using the software. A lack of correspondence might indicate that micros are not yet being used to improve educational processes. This concern is considered for Longsight school in Chapter Seven.

6.1.1 The Computer At Headland School.

At the time of the fieldwork, Headland school was found to have one BBC microcomputer system with colour monitor and disk-drive and no other peripherals. The school took advantage of the D.T.I. match-funding scheme and acquired their machine in 1984. The computer system, set up on a trolley, was timetabled so that each teacher had it for half-a-day per week. The timetable arrangement was as follows:-

	Morning	Afternoon
Monday		3rd Year Juniors
Tuesday	4th Year Juniors	
Wednesday	2nd Year Juniors	1st Year Juniors
Thursday		
Friday	Infants I	Infants II

In practice, this arrangement was flexible. The timetable arrangement was decided upon so that all staff and pupils could have the opportunity to use the computer. The Headteacher said that:-

> "the aim is to familiarize the children with the computer. For this, each class has the computer for a period a week... that leaves one-and-a-half days for anyone to use it... for teachers to appraise the software." (Hf84)

The youngest children use it, but the Deputy Head commented that he thought the older children (8+) benefit most (Hf{J85}4). The children usually worked at the computer in small ability groups and most often unsupervised by the teacher. The school had a fairly limited amount of software (a list of programs can be found at the end of this Chapter in the Notes section) most of which reinforce elements of mathematics and language work and back up class work where appropriate.

The computer at this school was also used by some teachers, on occasions, as a "reward", for those pupils who had completed class work, or access denied to those who had not. Mainly programs from the M.E.P. Introductory Pack were used, and at the time of the fieldwork, many of the teachers were at the stage of simply working though these.

6.1.2 Computers At Ben Mercy.

Ben Mercy first acquired a computer, colour monitor and cassette-player in the early days of the Government match-funding scheme (1982). The school quickly purchased a disk-drive, and during the fieldwork period, hardware provision increased dramatically. This was a result of the Head's own initiative. Following his secondment year (when he studied for an M.Ed.), he approached the Local Authority and suggested that his year's experience should be utilized:-

> "I tried to strike a deal whereby I said well if you give us some extra gear for us to do some development work, we'd be willing to use our school for in-service training at a later date." (Bi1).

Such a deal was struck, and in December 1985 the school received two further BBC micros, colour monitors, one single, and one dual disk-drive, and a printer. This meant that one computer system could be set up in the Infant department, another in the Junior department and the third in the Head's office, this latter being used for small group trial work, administration and for introducing the staff to different programs. Prior to the additional equipment, the single computer system had been timetabled in a similar fashion to the Headland arrangement: each class had the computer for a fixed half-day per week (Bf{J85}1). This arrangement was justified on the grounds that all staff and all pupils could use the micro, (although in practice, some teachers used it more than others). However, the timetable was abandoned even before the school received the extra equipment. The arrangement was found to be unsuccessful because teachers felt compelled to use it, when it was their turn, although it could have been put to more fruitful use with other groups (Bf2). The Headteacher explained:-

> "We started off by everyone having a session on the timetable every week so that Mrs. X knew that on Tuesday afternoon at 2 O'clock she would have the computer, regardless of whether she wanted it or not. This was really the big fault I think. But when there was only one computer, and when it was a case of really getting everyone used to using it, it was the only way I suppose." (Bi5).

But he continued:-

> "Even before we had the extra computers we changed the arrangements, because, for example, we found that Standard I doing 'Granny's Garden', for a term... would find that, if they only had the computer on Thursday afternoons at 2 O'clock, or 3 O'clock, just as they were getting into the spirit of the thing it was time to pack up and give it to somebody else and it really defeated the object of the whole exercise, so we decided to put it on a priority basis - in other words, it was up to every teacher to make a case for use of that computer, then it was up to me to decide who got first go at it, and when, and for how long, and I think, in <u>our</u> case, that worked far, far better. Now it's easier, we've got three and there isn't the same problem... but when there was only one it didn't really work at all on the timetable basis." (Bi5).

If what has been revealed already about the schools, Ben Mercy and Headlead, is considered for a moment, it seems that there is a dilemma between giving each teacher and each class equal access to the computer, and the reality of the situation in which it is understood that not every teacher wants to use the computer every week, and that some work would best benefit from a continuous period with the computer. Ben Mercy has employed both strategies and has come out clearly in favour of access to the computer upon the teacher's request.

The software employed by Ben Mercy also reflected the school's heightened awareness of microcomputer use across the curriculum. The school had the usual supply of M.E.P. Micro-Primer programs, but additionally made use of simulations (adventure games, for example, "Dragons' World", "Granny's Garden", "Adventure Island", "L-Mathemagical

Adventure") and "Quest" (a database program) amongst other software (see the Notes section at the end of the Chapter). On the Micro-Primer pack, the Head commented that it was really adequate in the early days because:-

> "most of the people on the staff had never used a computer... and the stuff in the microcomputer pack was easy enough to use and you didn't have to do great chunks of reading-up before hand... and in that case it served its purpose I think." (Bi4).

Since those early days, the school had been trying to build up a library of software across the curriculum:-

> "we've tried to get good drill-and-practice programs; we've tried to build up a suite of Infants' programs; we've tried to build up a library of simulations and adventure games and things like logic and problem solving exercises. And really, quite honestly, I haven't set out with any idea of going down any particular avenue; I've just tried to get hold of good software as broadly based as possible." (Bi6).

The Head's awareness and acquisition of software came partly from the secondment year. But additionally, computer magazines ("Educational Computing", M.A.P.E. - Micros And Primary Education) were read. The school had about £300 worth of software but much of this was demonstration software, freely copied software and acquisitions from secondment (Bf11).

Other than simple drill programs, the application of the micro was seen as fitting in with the project work and its encouragement of problem solving. Adventure games were thought of as particularly valuable since they absorbed the pupils and stimulated much creative work (Bf{J85}3). The database work was also linked to the project work on "food". The children gathered information on pupils' weight, height and waist measurement, whether or not they walked to school, performance on a lung capacity test (blowing bubbles in water after exercise) and other data. The object of the exercise was to provide the pupils with experience of data gathering skills (including accurate measurement) and later to raise hypotheses and question the database via the computer. Such questions were anticipated to be of the type "is there any link between the amount of exercise taken, weight of pupils and food intake?". This work is examined in greater detail later.

Ben Mercy school so utilized the computer in a wide variety of ways. Indeed the introduction of the computer has affected the curriculum (in that, as noted earlier, work with the program "Adventure Island" stimulated the Head to adopt a project centred approach for part of the school day). In this sense, Ben Mercy's use of the computer was significantly different from that of Headland's. The latter school was more at the stage of running through the simple drill programs.

6.1.3 **Two Approaches To Computer Education.**

An interpretation of computer education may be implied from the software used by the schools. Using Kemmis' paradigms, Headland school could be seen as employing the computer in ways appropriate to the Instructional paradigm. Most of the programs relate to the teaching of basic numeracy and literacy skills (for example, "tables", "spellstar", "story", "rally A and B"), reinforcing simple skills (an aim of the school) and generally supporting the existing curriculum, not improving the quality of educational processes. Much of the computer work at Ben Mercy school falls under the Revelatory paradigm. The work with adventure simulations (encouraging logical thinking, problem solving, decision-making) is particularly appropriate to this paradigm. At this school the computer had an impact on the curriculum: rather than supporting what went on, the computer work enhanced, and to some extent changed the curriculum, improving the quality of educational processes.

Longsight school is studied in a separate chapter, but it may be of value to briefly mention that the computer work at this school could be seen as relating to the Conjectural paradigm. Logo, encouraging hypothesis building and conjecturing, clearly fits within this educational paradigm, and using Logo has the potential to change the curriculum, improving the quality of educational processes.

Obviously, the reality is not as straight-forward as the picture just painted. Such claims about the interpretation of computer education and judgements about improvement of educational processes implied simply on the basis of the type of software used by each school, could be made without even entering the schools. But one of the important gains of intensive case study research is the opportunity to examine whether or not the implied interpretation of computer education actually corresponds with the schools' intentions and with what teachers say and do. This is important since there is the distinct possibility that programs could be used by the schools for purposes quite different from those intended by the designers. So, a relevant question to raise is "is there a correspondence, or a discrepency, between the official purposes of the type of software used and the purposes and intentions of the teachers in using the computer(s)?".

The concept of computer education, implied from the software used in each school, will be considered together with teachers' own interpretations of the concept, in order to discover whether or not there are such correspondences and discrepencies and whether or not the computer is really improving the quality of educational processes.

6.2 Correspondence At Headland?

The first question to be considered is "does the Instructional interpretation of computer education, implied by the software in use at Headland school correspond with the teachers' own interpretations?".

From studying the school, there seems to be some doubt about this. Upon closer examination it seems that Headland has not overtly chosen the Instructional interpretation of computer education. Indeed, the teachers there appear not to have come to terms with the concept of "computer education": although the software used implicitly implies an Instructional interpretation, this view of computer education has not been explicitly selected in favour of another. If the Instructional model had been adopted, then aims would be in terms of improving the effectiveness or efficiency of the curriculum, and the computer would be used to back up, or support, what already goes on in the school, rather than actually improve the quality of the educational processes the school provided. However, when Headland schools' teachers' words and actions are examined, it is clear that they generally do not view the micro in this way.

6.2.1. Teachers' Words And Actions.

As has already been stated, the Headteacher believed the aim was to "familiarize the children with the computer" (Hf84). Programming was not taught although, he suggested, it might be possible to teach it on a one-to-one basis (Hf85). He gave the impression that he thought it was expected that schools should teach programming.

The teacher of the fourth year Juniors (the Deputy Head), on one occasion, expressed the opinion that the Headteacher was not too concerned with computer education: I was told not to worry much or bother with the

Head as "he's not really interested" (Hf53). [Initial access was negotiated with the Headteacher, but he was away through illness for the majority of the fieldwork. For this period, the Deputy was Acting Head].

As for the Deputy, from his work with the computer and what he said, it became clear that his main objective was to work through all the software the school possessed. Indeed he claimed that his class had already gone through most of the programs (Hf50/51). However, on one occasion, when this teacher left me to select programs to use, it was discovered that at least some of the children were not familiar with several of the programs. They did not express any preference either, except for "Hopper", an arcade type game (Hf60-63). It could be that these pupils <u>had</u> run through most of the programs, but found them unmemorable. Although the programs used were of an instructional nature, it appeared that the teacher of the fourth year Juniors had not overtly adopted the Instructional paradigm since the computer work was neither followed up nor used to reinforce or complement what went on in the lessons (Hf26). His class most often ran through the programs unsupervised and usually no record of their work was requested. One girl found it strange that I should be noting down what they were doing; this was clearly not the norm (Hf27). This teacher seemed to be of the opinion that since the computer and some software were there, it was his duty to work his class through most of the programs. Having done this, he believed that what was then needed was someone to write programs specifically for the school (Hf51), although, he seemed unaware of the variety of software available at that time.

The teacher of the third year Juniors admitted that he did not feel particularly confident with the computer (Hf63). He had had high hopes but had been disappointed with using a tape machine for loading. This teacher (like most of the teachers in the school), gave the impression that he had not thought a great deal about the implications of microcomputers in education, but additionally, he had not spent much time exploring the school's software (in the way other teachers had). Indeed, he confessed that he did not really know what software the school had (Hf65). On the first visit to his class, I was informed that his pupils had been doing some work on co-ordinates and he wondered if there was a program relevant to this. He did not know, nor did I, but neither did the teacher of the fourth year Juniors, despite having worked through most of the programs! (Hf65). In fact, on all the visits made to the third year Junior class, the teacher always asked me to select the programs to use with the pupils. His unfamiliarity with the school's software was evident on another occasion when I asked him how to use the "Eureka" program, as no notes for this were available. He had no idea (Hf72). This teacher had apparently thought little about computer education and had certainly not specifically selected the Instructional paradigm. He appeared to be simply of the opinion that it was good to give the pupils practice at using the computer (Hf73). <u>What</u> they practiced seemed pretty irrelevant. Had it not been for my visits to his class it is doubtful that he would have used the computer (despite his timetable slot).

My first visits to the school were made to the teacher of the second year Juniors. She gave the impression that, of all the teachers she had given most thought to the application of micros in primary education. She was more conversant and confident with the computer than the other teachers and I was aware that the school felt more secure putting me (an unknown entity) with this teacher first. (As my relationship with the school built up, access to the less confident teachers was permitted). She had been on a basic introductory course and had been learning to program at evening classes (Hf3). Like the teacher of the fourth year Junior class, her class was working through the school's software, but she made effort to use the computer to reinforce the work the pupils were doing in the class. As an example, she made use of the M.E.P. "tables" program; the children went to the computer in ability pairs and ran through a 20-questioned tables test, which allowed 10 seconds for each answer. This program was selected because it was thought to reinforce the work the class had done on their tables. After the test, the program will revise the incorrect answers, but this section of the program was not utilized. The teacher thought the remedial work would be beneficial but exclaimed that there was simply not enough time (there were 34 children in this class) (Hf4/5). The pupils also kept a record of their computer work. This usually amounted to writing down a score next to their names on a piece of paper she provided. However, despite linking the computer work and keeping some kind of record, she was not particularly concerned if some pupils did not have opportunity to use the program(s), through pressure of time (Hf12).

At the time of the fieldwork, this teacher had not formed any particular preferences for the school's software (Hf3), nor did she seem aware of other software that might be worth purchasing (Hf12). This was of particular concern since of all the teachers she appeared the most knowledgable about micros.

Not a great deal of time was spent with the first year Junior teacher or the Infants' teachers. These teachers, despite having the weekly timetable slot expressed some uncertainty about using the computer: the first year Junior teacher had some trouble loading programs from disk (Hf57) and one Infants' teacher commented that she knew nothing about computers, saying "give me a piece of paper and pencil any day" (Hf52).

To add further colour to the picture of microcomputer use at Headland school, an example of work around the micro will be presented. Such a single illustration may not, itself, be of great value, but it should give more of an idea of the general approach taken to computer education. The example given is not untypical of observations made at Headland school.

6.2.2 "Spellstar": An Illustration Of Computer Use.

On the occasion chosen for illustration the computer was timetabled for a morning with the second year Juniors (Hf8-12). Their teacher had decided to employ a program called "Spellstar". The program tests the pupils' spelling of a list of words, in this case selected by the class teacher. It had not previously been used in her class. The teacher had selected the following ten words:-

WOMAN CHANGE COLOUR JESUS ORANGE CLOTHES THINK CLIMB BREATHE WEATHER.

These were selected because they had been misspelt in written work and had gone into pupils' "word books". The class had not been tested on them before. A target time to beat was also set, at five-and-a-half minutes.

When the program is run a word appears on the screen; the pupil looks at it for a few seconds until it disappears; s/he then types in the spelling and presses the RETURN button. If the word is spelt correctly the next word appears; if the word is spelt incorrectly, the child's attempt appears on the screen again and is "corrected" by the computer. The pupil then has a second attempt at the spelling. This continues until the word is spelt correctly.

This program was used for the whole morning. Pupils were sent to the computer in ability groups of two. They had a turn at the test and then returned to their class work (writing). Most couples spelt words alternately, although one would proffer a spelling if the other did not know. The following table shows how the pupils fared:-

PUPILS	TIME	NUMBER RIGHT FIRST TIME	WORD(S) SPELT INCORRECTLY
A & T	2m30secs	10	
L & J	3m30secs	10	
J & K	3m	10	
P & S	3m	10	
R & C	2m30secs	10	
N & G	4m30secs	8	woman orange
M & D	6m30secs	9	woman
M & S	5m30secs	6	woman Jesus climb weather
A	7m	5	woman colour orange clothes breathe
G & L	4m	9	breathe
V & B	3m	9	colour
D & E	15m	1	All except colour
A & D	4m	8	clothes weather
K & D	9m30secs	5	change orange clothes breathe weather

A quick glance at the table shows the length of time pupils took to run through this simple program, the number of pupils in the class (and two pupils did not have time to take their turn) and the wide variance in ability.

Two questions immediately spring to mind: "what did the pupils learn?" and, "could the exercise have been carried out equally successful without employing the computer?". This latter does depend on the teacher's intentions in using it.

In response to the first of these questions, it is doubtful that the pupils learnt a great deal. For those pupils who correctly spelt the words then it may be supposed that they could spell the words before the exercise. For those who misspelt some words then it may be that these particular pupils did in fact learn a few spellings. However, it could not be said that the computer "taught" the pupils, although the "correcting" of the misspelt words might have been expected to instruct them. To substantiate this, in this example alone, there were several occasions when the fourth attempt at a misspelt word was the same as the first. The pupils did not seem to learn from the computer. This does not seem so surprising when the way in which words were corrected is examined. To take an instance, WEATHER was misspelt WEARTHER. A teacher would quickly indicate that the only thing wrong with the spelling is the extra R towards the beginning. However, the program first checks each letter for its presence in the word, and discards any others in a "waste bin". In doing this, the order of letters is not considered, so on coming upon the first R, the program recognizes that there is indeed an R in WEATHER and so continues along the word, but of course, when the second R is reached the program registers this as extra, and so in the "bin" it goes!

```
          W E A R T H E R
                        |
                        |
                        |
                        v
                 ||||||||||||||||
                 |   WASTE    |
                 |    BIN     |
                 |____________|
```

Having done this, the remaining letters, WEARTHE are checked for correct positioning. Only the first three are right, so the pupil is presented with:-

W E A _ _ _ _

The last four letters are reorganized and finally the waiting pupil is shown the correct spelling.

Clearly this could be confusing for children. A further serious design fault of this program is that, at the end of the test, all the words, that were not spelt correctly the first time, are listed across the screen, and where there are more words than will fit on a single line, the word at the end is split, for example, as actually happened:-

```
W O M A N   C H A N G E   J E S U S   O R A N G E   C L O T H E S   T
H I N K   C L I M B   B R E A T H E   W E A T H E R
```

Rather than helping children learn the spellings of a few words, this program could be seen as hindering their grasp of spelling.

In response to the second question about whether the activity could have taken place without using the computer, as long as the teacher's sole intention had been to check the spelling of the ten words, then clearly the computer need not have been used. Indeed the activity could have taken place more efficiently, and in a less confusing fashion, without its use. However, it is probable that the reasons why the teacher decided to employ the computer in this exercise were not so straight-forward. It is likely that the decision was influenced by a number of factors: firstly, she had been timetabled for the micro so felt obliged to use it for something; secondly the program "Spellstar" is simple enough for pupils to use unassisted; thirdly the program is short enough for all pupils to have a turn; fourthly, and quite simply, it gives the pupils chance to use the micro; fifthly, it might have been hoped that a few pupils would learn a few spellings. There could, of course, be further reasons for using that program. Bearing this in mind, it would be unjust to condemn a busy teacher for selecting such a terrible program. If she had had more time to assess the school's software, if funds had been available to buy more exciting software, if those around her had been more enthusiastic and if she had had adequate in-service training, then that program would probably never have been used. This example has, if nothing else, revealed some of the constraints teachers operate under.

6.2.3 Computer Education At Headland.

To return to the question raised earlier, it is clear that although most of Headland school's software was of an Instructional nature (for example, "teaching" the pupils something as with "Symmet", "Vennman", and often using rewards - "Brick-up"), it would be incorrect to say that an Instructional concept of computer education had been adopted. The teachers' awareness of the different types of software (and in some cases the school's own software) was low. Quite apparently this school had thought little about computer education as such, and was simply exploring the M.E.P. Introductory software. Clearly there is a danger in assuming that the type of software a school uses reflects a certain interpretation of computer education: this may not be the case, as it is not the case for this school. Such a correspondence should not be assumed. It is only after some indepth study that such judgements should be made. The danger of making assumptions from information alone, without first-hand experience, is also apparent if the following "facts" about Headland school are considered. The school:-

(1) was selected by Mr. Dafydd Price (the then M.E.P. Wales Primary Co-ordinator) as using microcomputers;

(2) had invested in a disk-drive;

(3) is open-planned;

(4) wants more equipment.

On the basis of this alone, it might be anticipated, or dangerously assumed, that such a school had put considerable thought into the introduction of computers in primary education, and that the school's micro was making some impact on the curriculum. It is only after a number of visits that the reality emerges. At Headland school, the micro was not seen to influence the class work, make an impact on the curriculum or improve the quality of educational processes.

The second question that will be considered is "does the Revelatory interpretation of computer education, implied by the software used at Ben Mercy school, correspond with the teachers' own interpretations?"

6.3 Correspondence At Ben Mercy?

Although a variety of different software was employed at Ben Mercy school, it might be said that, from the work that had been done with the adventure simluations, the school adopted a Revelatory interpretation of computer education. To make such an assumption would be dangerous, as the discussion of Headland school has revealed. Additionally, it would be unjust because it would largely ignore many other kinds of software that were used by this school and which fit into other paradigms: just because the number of simulation programs used was quite large, it does not necessarily indicate that most time was spent using them, for, although "Quest" (a database program not necessarily fitting into the Revelatory paradigm), for instance, may only be listed as a single computer program, the time involved in using it may be great. Judgements about schools' interpretations of computer education should not perhaps be made before activities in the school have been observed over a period of time, and then it needs to be remembered that interpretations change.

From study of this school it is clear, although difficult to articulate, that the interpretation of computer education was very different from that at Headland. For one thing, the micro was employed across the curriculum: work was not simply confined to reinforcing basic skills and supporting the existing curriculum. At Ben Mercy the micro had, at least on a few occasions, "pushed out the horizons of the curriculum" (Bi10). The Headteacher said of the simulation program "Adventure Island":-

"We found that as we got into that project we were going further and further and further out and looking at things which (a) we didn't have time to do normally and (b) we wouldn't even of thought of and (c) even if we had thought of them, we wouldn't have thought the children capable of handling. So it definitely lifts the whole level of your learning." (Bill)

This is an instance of the computer stimulating change in the curriculum. But not all of the micro work at Ben Mercy changed the curriculum. The school also used Instructional programs. Most of such programs were used to develop skills (for example mental arithmetic - "Number Painter", reading music - "Note Invaders"), or to back-up class work (for example, co-ordinates - "Pirate"). The Headteacher thought that there was a place for drill-and-practice programs in the more formal aspects of the curriculum (Bf7). The school had also found that, for the Infants at least, there was a shortage of non-instructional software, and so drill programs, such as "Infant Number" and "Infant Letter", were used at the school (Bf10). Some of the M.E.P. Micro Primer programs were used, although the Head did not rate these highly (Bf59). The Instructional programs "Number Painter" and "Note Invaders" were particularly well favoured by the Head who said that they had been used successfully with all the Juniors (Bf67). Apparently, all the teachers in the Junior department had used "Number Painter" and found it useful, one teacher commenting, "it makes the children use their brains" (Bf69). The Head explained the value he saw in "Note Invaders":-

"children who have been learning to play the recorder - or more correctly, children who have been sitting in recorder lessons for the last two years and still looking out of the window, and particularly boys who think it is a bit sissy when you're eight-years-old to learn to play music, find them having tried 'Note Invaders', which is a very simple drill-and-practice program (they don't get any easier) and yet those boys, because there's an element of gamesmanship, suddenly find that, without realising it, that they'd learnt to read music." (Bi10).

The school was also exploring the use of the computer as a database. The "Quest" program was used over a number of months with a Junior class. The intention behind using the computer as a database was to encourage pupils to form hypotheses and use the micro to search the data for relevant information. In this sense the micro could, in the first instance, be seen as fitting into the Revelatory paradigm in that it encourages hypothesis forming, and in the second instance, in its data-searching role, as a labour saving devise, i.e. within the Emancipatory paradigm. An outline of the database work is provided later.

The school was also investigating the use of the micro as a word processor. However, it had been found that it is difficult for children to benefit from word processing when they find typing laborious. The Headteacher decided to concentrate the work with the younger children in the hope that, in a few years, they will be able to benefit from word processing in terms of drafting and editing written work. With this in mind, the first year Juniors were working on it - more familiarization, than anything else, to begin with: if a pupil had written a good poem for instance, s/he was allowed to type it out using the word processor, with the improvement of presentation in mind (for example writing words in capitals for emphasis) (Bf71).

Additionally, the school was planing to use the Welsh version of Logo. From a look at the software alone, it could be anticipated that the school was not simply adopting a Revelatory interpretation of education. A consideration of teachers' words and actions reveals more.

6.3.1 Teachers' Words And Actions.

Most of Ben Mercy school's interpretation of computer education centred on the opinions of the Headteacher. This was simply because his influence in the area was strong. Here indeed, is a stark contrast between the schools Ben Mercy and Headland: regarding computers, Ben Mercy had a Head who was interested, enthusiastic, open-minded and at the same time, realistic. He believed that children should be given first-hand experience of technology on a broad a basis as time and resources allowed. He seemed convinced of the educational value of microcomputers and yet, he did not think that:-

> "one should have to justify educationally immediately every single step in school... I don't think that you should have to sit down very carefully before providing every experience and making sure that this is fitting into a grand design or anything - I'm all for kids having experiences on a broad a front as possible." (Bi20).

The Headteacher was open-minded and willing to explore a variety of avenues of computer education, but at the same time, his attitude was not uncritical; for instance, he recognized the limited value of some of the early M.E.P. drill-and-practice programs and was also critical of some simulations (for example, "Flowers of Crystal" which he felt could frustrate children) but was not dictorial enough to prevent other teachers using such programs if they desired, since he believed that there were no hard-and-fast rules governing the assessment of software. His approach was to explore avenues and then assess the value for himself: in this he was realistic rather than evangelical; for instance, he was realistic about the practical difficulties in building up database files - he was keen to utilize that capicity of the computer, but as a compromise, he recognized the value of using ready made databases (Bi8).

One of the important points of contrast between Ben Mercy and Headland is the direction of the Headteacher with regard to computer education. In respect of this, it was important to observe the other members of staff at Ben Mercy and learn about their interpretation of computer education. Were they uncritically guided by the Head? Had _they_ given thought to the implications of the introduction of microcomputer? From the fieldwork, some incidents would suggest that some of them had not: on recommendations from the Headteacher, some of the staff tried out programs without any preconceived aims. Some of the staff have expressed reluctance in using the micro; others have shown some lack of competence in handling the actual hardware. One teacher, when she had finished using a program (which and been loaded by the Headteacher) was not sure what to do next and asked "should it just be turned off now?" (Bf4). The Head spoke of the initial reluctance he experienced from the staff (Bi18), most of all from the younger members, which he found surprising. One teacher (of the Welsh third and fourth year Junior class) had a rather negative Ludite attitude: in the Head's words, he thought the computer was "a useless toy" (Bi18):-

> "he really isn't keen on computers - he's more concerned with poetry and playing the fiddle and a machine doesn't fit into his life attitude." (Bf64).

The Head found it difficult to change such an attitude. He spent time introducing the staff to different programs, and on one occasion, as a result, this particular teacher _did_ use a program with his class, but his interest sprung from somewhat uneducational roots; he liked "Viking England" because he had done well at it, getting a "good" score (Bf19): his interest had not sprung solely from educational grounds.

The other younger member of staff who had shown most reluctance was in the Infant department, but her reluctance was more the result of a lack of quality Welsh software suitable for Infants, and as the Head explained:-

> "she didn't want to take an English language computer into a Welsh learning environment for obvious reasons." (Bi18).

In the early days, the Headteacher saw his main task as getting the staff to loose their fear of the computer. Increasingly, his aim became to heighten the staff's awareness of the variety of software. Consequently, he felt that the onus was on the teachers to make requests to use the computer and to substantiate their case. But it did seem that in practice the teachers used the micro on the Head's recommendation: micro work was rarely initiated by the teachers. There were occasions though, when individual staff did make requests. On one visit, an Infants' teacher expressed her desire to use the micro, and she knew exactly which disks she wanted to try (Bf51), but in reality, even the Headteacher himself doubted that much would be going on without him:-

> "if it was left to the teachers, they wouldn't discover anything new or keep up to date - they'd just use the odd program they'd found and liked... But even I can't keep up to date - it's a full time job." (Bf65).

It is important to recognize the influence and effect of the Headteacher, for, without him, it is probable that this school would use the micro in a similarly limited way as it was used at Headland school. The odd remark from a teacher can be quite revealing. For instance, during the Quest work with the third year Juniors, on one occasion, the class teacher requested the removal of the computer from her room as she found the work distracting and taking up too much space (Bf36). Another teacher commented that she was "too busy with the new project style of teaching to use the computer" (Bf7), revealing that for her, microcomputers were probably peripheral. But it was some consolation that, rather than being blind to reality, the Head was aware that, despite his efforts, the future of computers in his school did not look "too bright" (Bf65). Having said that, the picture was not that bleak for his efforts did have some effect, for instance, the attitude of the Infants' teachers had changed:-

> "they weren't too favourably disposed to the computer to begin, but now they're interested in what it has to offer." (Bf42).

Additionally, the Head saw a chance of heightening his staff's awareness of computer education in the future, via a rather back-door route: the County promotes the Welsh version of the word processing package "Edword", primarily in relation to Welsh language development, computer education being secondary. Because of this, all the teachers at Ben Mercy should go on an Edword course, in this way, letting the micro "in through the back-door" (Bf77).

Once more, it is apparent that in educational settings it is essential to find out why such an approach was taken - it is insufficient simply to conclude that because X was done, the teacher had Y intentions. Most of the staff were using the micro at Ben Mercy in some ways which seemed to imply a particular interpretation of computer education, but on further examination, it is clear that usually the teachers were so doing, simply on the recommendations of the Head, and that in the future they could be using the microcomputer, not for any preconceived development of computer education, rather, in their eyes, for the development of the

Welsh language. This would indicate non-correspondence with an assumed Revelatory interpretation of computer education.

An outline of the database work should provide further information for the assessment of whether the computers were used to improve educational processes, as well as lending support to the argument that particular computer applications do not mean a corresponding interpretation of computer education. The illustration also reveals some of the unforseen problems that can arise when a micro is employed in the classroom, particularly with software of an "open-ended" nature.

6.3.2 "Quest": An Illustration Of Computer Use.

The third year Junior class was first introduced to the "Quest" program towards the latter part of the Autumn term (1985). The first sessions were concerned with familiarizing the pupils with the program, but the overall plan was for them to utilize it as part of the following term's project on food. The Headteacher took charge of the work. In the introductory lesson he talked about organizing data and preparing facts. The task of the class was to develop a questionnaire which could be administered to all pupils at the school and provide some information about eating habits and fitness. By the end of the session the following questions had been considered (Bf6):- SNAME (surname); FNAME (first name); AGE; CLASS; ADD (address); HT (height); WT (weight); SX B/G? (sex - boy or girl?). The class was requested to think of other suitable questions to include over the next few days.

Bu my next visit, changes and additions had been made to the questionnaire and the following decided upon (Bf14):- SNAME; CNAME (Christian name); DOB (date of birth); ADD; SX; HT; WT; WST (waist measurement); SHOE (shoe size); BFAST (food eaten for breakfast); SNCK (snack eaten at Break); REGEX (regular exercise); BTIME (bedtime). Each class member had completed a questionnaire and the Headteacher had typed the data into the computer. This had raised some minor problems which were reported to the class: shoe size had been converted to continental sizes otherwise size 13 would appear larger than size 1; bedtime had been converted to the 24-hour clock. In this session, the Quest program was demonstrated. There were new commands to learn, such as "query", "ident" ("identical to...") and "nident" ("not identical to..."). First, some of the completed questionnaires (files) were shown on the screen. Then, prompted by remarks from the class, two scattergrams were shown (weight against shoe-size and weight against height), explained and discussed (the pupils were previously unfamiliar with these). The information was also represented by bar-charts.

Throughout the session the children were interested and responsive. Interestingly, when discussing the scattergrams, the class worked out who several of the points represented and said things of the sort "there's Richard, at the top because he's the tallest" (Bf15): the graph was more than a simple representation of data; the dots referred to their class-mates. This data was personal (or in a sense, concrete) to them.

On the next occasion, (Bf22/3), a small group of pupils had a go at searching the data for themselves using the computer set-up in the Head's office. They had a go at printing out selected parts of files (for example, PRINT SNAME CNAME WT), but problems were soon encountered: not all the files would appear on the screen. Each time, at the same point, the error message came up "bad data". About 10 to 12 files could not be printed out. The Head tackled the problem but was unable to find a solution. It appeared that the computer itself was not at fault as other files could be printed out, but there was the possibility that the disk was in some way damaged. The problem was unsolved by the end of the school day, and with Christmas approaching, it was decided to drop the Quest work until the next term, by which time it was anticipated that this problem would have been resolved.

Upon renewed visits to the school in the Spring term (Bf26), it was discovered that all the data files had been lost because the disk was damaged. The Head had begun re-filing the data, making certain changes. A teacher-directed class discussion on the alterations ensued (Bf32/3). The class had not worked on the questionnaire for several weeks but their memory of it, and enthusiasm for it, was high. The first ten questions had only changed in a minor way to become:- SNAME CNAME DOB ADD SX CLASS HT WT WST BED.

BFAST SNCK REGEX had been removed and replaced with EX for exercise (some kind of measure of fitness). The Head asked, "how might someone's fitness be measured?". Answers varied. The effects of exercise on the heartbeat were discussed in conjunction with the suggestion that pulse rate might be taken. It was also suggested that exercise and fitness were related to panting, namely that less fit people pant more with exercise. The class were left to mull over the question further.

The session was only short, but it served well to remind the class of the previous term's work and to raise further questions about what ought to be included in the questionnaire so that the hypotheses, that were being raised, might be tested.

Over the next week-and-a-half the questionnaire was developed further. Two tests of fitness were included; the pulse rate after exercise and the bubble test. The latter consisted of blowing through a straw into water and measuring, in seconds, the length of continuous bubble making, thus giving an indication of lung capacity. The questionnaire had then been duplicated and looked like so:-

surname	SNAME										
Christian name	CNAME										
date of birth	DOB	date(in no.s)	month (shorten-ed to 2 lets)	year	(2 no.s)						
address	ADD	(enter estate name as one word)									
sex	SEX	B	G								
class in school	CLASS	D4	D3	3/4C	D2	D1	1/2C	B3	B2	B1	BCRM
height (cms)	HT										
weight (kgs)	WT										
waist (cms)	WST										
normal bedtime	BED	(use 24-hour clock e.g. 6pm is 18.00hrs)									
do you usually walk to school?	WALK	YES	NO								
pulse rate after exercise	EX										
lung capicity (bubble test) (in secs)	BUBBLE										

In the afternoon, three boys and three girls accompanied the Headteacher to the back of the classroom where the computer was set up. The boys were posted at the computer to read out, type in and check the completed questionnaires. The three girls were put in charge of the supervision of the completion of the questionnaires, carrying out the measuring and testing and acting as clerks in the form-filling. The Headteacher emphasized that consistency was needed in the form-filling and explained the following: how the date of birth should be shortened; how the 24-hour clock should be used for recording bedtime; that height and weight should be measured barefoot; how the bubble test should be carried out and recorded; what the exercise involved (stepping up and down from a chair for one minute) and how and when the pulse rate should be checked (Bf37).

Yet, despite several previous alterations to the questionnaire, there were still problems. It turned out that in practice, the children were unable to check pulse rate. What could be done instead? One girl suggested that puffs could be counted, but it was forseen that this would also be problematic (difficulty of counting and problems of cheating). After some thought, the solution was seen as employing the bubble test both before and after the exercise. This remedy proved satisfactory.

It was also decided to round down weights to the nearest whole number.

By the end of the afternoon, all six pupils had completed their questionnaires. A watch had been used to check the timing in the bubble test, but in future, a stop watch would be used.

At this point it was becoming clear that the whole exercise of gathering data was much more involved and time-consuming than had at first been expected. The forms took considerable time to fill out and problems seemed to crop up constantly. To gather data on the whole school would be too great an undertaking; they would have to be content with measuring just the Juniors.

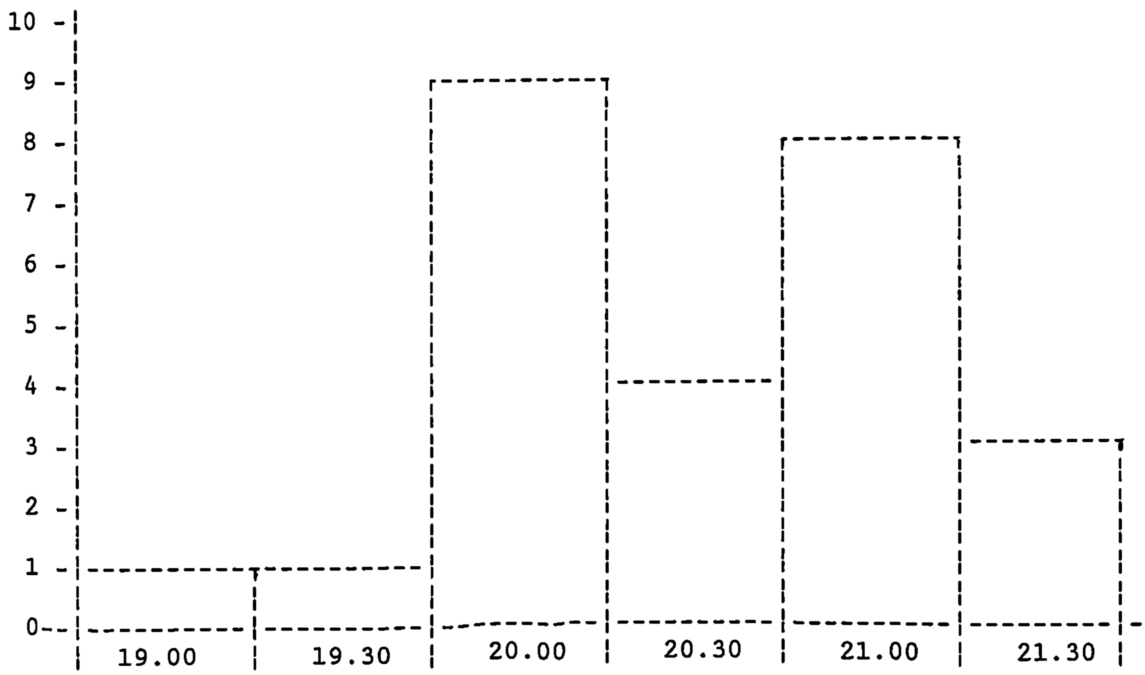
At the end of that afternoon too, it was clear that the computer was not at the centre of the activity, rather, as the Head commented:- "it was being used as a tool, just as you might use a ruler as a useful tool" (Bf38). The computer was being used to store data. Much more power would be utilized when used to search the data.

By the following week (Bf44) quite a system for gathering and recording the information had been developed. Those who had been clerks last week had trained others; they themselves were now typing the data into the computer. As pupils came to have their details recorded, a clerk was always ready with a pen. The exercise and bubble-blowing measurements were taken by another administrator whilst the next pupil's details were recorded by the clerk. Completed questionnaires were handed to those waiting at the computer, where they were typed in. This system worked well and efficiently and was enjoyed by all those involved. But it still proved very time-consuming. Additionally, further problems of a technical nature were met. When the files were entered, all characters after mid-screen disappeared. During break, the Headteacher transferred all the data onto another disk, but unfortunately this did not rectify the problem. The Head pondered whether or not it might have something to do with the tracking (40 tracks on 80 mode) (Bf46). No solution could be found so the decision was taken that all the data should be re-recorded on a fresh disk. This meant re-typing the 18 files so far collected. The

Head volunteered to undertake this after school.

When I next visited (Bf51), most of the data on the class had been collected and safely stored on disk. The Head decided that it was time some of the data was examined. In the first instance the data was studied from the completed questionnaires, rather than employing the computer data-bank. The class was split into groups; a few finished questionnaires; a group of four boys studied the bedtime data and the two other groups worked on raising questions and hypotheses relating to the data.

The boys examining the bedtime information first made a tally of the different bedtimes. This had to be repeated as the numders involved did not match: 26 pupils in the class and apparently 27 pieces of data! Then, armed with the corrected tally, they accompanied the Headteacher to the computer set-up in the office. Here they coded in the data and produced a bar-chart like so:-



Having done this, the group was asked to write about what they had done and comment on the graph. This was taken up later in a class discussion.

The other groups had also been busy. It was interesting to note that those who had been working on raising hypotheses had only come up with straight-forward questions rather than ones of a comparative nature. Their questions were simplistic, for example: "who is the tallest?" "who goes to bed after 21.00?". They had not raised questions of the sort "are girls taller than boys? (comparing sex and height) or "do those who go to bed after 21.00 weigh less?" (comparing bedtime with weight). Only one question was asked that was comparative; one boy asked if there might be a relationship between weight and walking to school (Bf52).

Following Break, a class discussion took place. The whole class was shown the bedtime bar graph worked on by one group, and asked to comment on it. Various observations were made, for instance "most go to bed at 8 O'clock". The Head asked if the graph was unusual or unexpected in any way. The class remained quiet so he explained, in very simplistic terms, that a "normal" distribution might have been expected; from this data, few go to bed at 20.30 when it might have been expected that most would go then as it is a time between the earliest and latest bedtime. He asked the class to proffer explanations as to why so few go to bed at 20.30. It was suggested that maybe there is a good television programme on at that time, but from other responses it became clear that further questions about bedtime, and what it means, needed be asked, since some watched television in bed. Does going to bed infer going to sleep? As a slight aside, the Head inquired how many, in fact, watched television in bed; the responses perhap show the affluence of this community for 12 had televisions in their bedroom, 4 of those being colour! Further questions were asked of the class and it was found that 12 had videos at home and 17 had computers! (Bf53). Attention then returned to the bedtime data. One boy had raised the hypothesis that those going to bed earlier did better in class than those who go to bed later and are tired. How might this hypothesis be tested? The class put forward various suggestions: perhaps tiredness could be measured by the number of yawns; this was quickly dismissed as impractical. Another pupil suggested that a timed test, in maths for example, would show up the tired ones; objections were soon raised - such a test would be unfair on those who work slowly anyway and not because of tiredness. The class quickly became aware of the difficulty of testing hypotheses unobjectionably.

Before the end of that session, the Headteacher pointed out that it would have been quicker to have asked the class quite simply "who goes to bed at 8 O'clock, 8.30, (and so on)?". The computer need not have been used at all. However, he suggested that the data the class were gathering covered more than just bedtime and that the computer would prove more useful as the number of files increased. (At this stage the intention was to gather data on the fourth year Juniors too).

By the end of the lesson, the Headteacher thought that valuable work had been accomplished that afternoon. He was pleased to have seen the pupils raising questions and engaging in discussion, and although the computer had played a minor role in the activities, he felt that it had prompted much of the work. However, despite the data-gathering activities having stimulated some worthwhile learning, it was decided not to pursue it further, for a number of reasons, not least of all the lack of time. In addition, it was felt that to continue the work would disrupt the work that a teacher trainer needed to do with the class (Bf55).

The Headteacher saw great value in the Quest work so far experienced and hoped to continue it at a later date. However, in the event, it remained unfinished (Bf76). Later, when I asked him about using the computer for database work he reflected:-

> "I think it's got a lot of potential - I wish we'd got more time. The trouble we've found with using a database, if you go beyond the very simple Fact-File type database..., the amount of time it takes to build up your data file... it's extremely time consuming... unless it's going to be an on-going project, for example, from year-to-year-to-year so that you can... build up quite a substantial amount of data - in a case like that I think you could probably justify the time spent in in-putting data into your files - on the other hand, very often, I think, you're going to defeat the object of the exercise, or one of the objects of the exercise of using a database in that it allows you to lift your level of investigation from purely recording facts and so on, to forming hypotheses; well, if you're going to spend the time you previously spent deciphering data... on in-putting it, you still haven't got time for working out your hypotheses. So I think there's a lot to be said... in using ready made databases." (Bi7/8).

The Headteacher was of the opinion that, although using the computer as a database could, in theory, encourage hypothesizing, in practice, as his experience substantiates, the time required can prove too restricting. This class's experience was also fraught with problems of a technical nature, problems which could have so easily deterred a less knowledgeable and enthusiastic teacher.

Yet it was found that despite all the problems, using the computer for database work had enhanced the curriculum in a number of ways - it had stimulated learning, incidental to the main task but which had value in itself. This incidental learning included form filling, measuring with accuracy, and consistency in recording results, (amongst other things) such activities that might not have otherwise arisen. The 24-hour clock was an example of learning stimulated by the work: the Head reported that the class had not been introduced to it before, yet had grasped its concept very easily. He was suprised by the speed of their ability to use it. He put it down to the fact that the questionnaire demanded it use; the children had to use the 24-hour clock so learnt about it almost by themselves (Bf45). He also commented that children had dealt with co-ordinates very easily after working with the simulation program "Adventure Island", remarking that, in the past, it had taken hours to teach children to use the 24-hour clock and co-ordinates. He suggested that the computer could be valuable in the creation of situations which demanded certain skills; children see the need for them and so learn them quickly and easily. In this instance, the gains from using the computer came not from the anticipated development and testing of hypotheses, rather from the incidental work it stimulated. This again serves as a reminder that it is unwise to assume that a certain interpretation of computer education has been adopted simply because a particular package is used in a school.

6.3.3 Computer Education At Ben Mercy.

In one sense, the computer work at Ben Mercy was like that at Headland; both schools were exploring various programs - trying things out and seeing what happened - but they were importantly different: the work at Headland was unadventurous, not really extending beyond the use of drill-and-practice programs. The work at Ben Mercy was far more varied, some of it leading to curriculum change. However, because the work was so varied, it is difficult to pin the school down to a particular interpretation of computer education. Indeed, as has been mentioned already, the Headteacher had not set out with any idea of exploring one particular avenue. His policy was simply to acquire good software as broadly based as possible (Bi6). This certainly implies that he had not consciously adopted one particular interpretation of computer education, although this would depend on the concept of "good software" employed. There is the possibility that "good software", in the Head's terms, was only that which fell under the Revelatory paradigm (in which case, it could be said that this particular interpretation had been adopted). However, it cannot be ignored that he also stated that he saw a place for "good" drill-and-practice programs. The Headteacher made it clear that he wanted to explore <u>many</u> computer avenues, but felt frustrated by the lack of time (Bf75). It seems that he would prefer to explore as much as possible and then perhaps settle on one particular policy regarding computer education. Besides this, the Head was aware that not everything will work out as expected (as with the Quest work), and that something that would suit him might not suit another teacher. Hence, speaking about new programs, he said that:-

> "unless it is blatently obvious that it's awful software, I tend to give it a try and see what people think of it." (Bi6).

This open-minded policy developed from his experiences: in the past, he had been surprised at how useful some fairly useless-looking programs had been, and equally surprised at how "lously" some very attractive programs had been:-

> "...I don't think... in my case anyway, and it's a personal view that lots wouldn't agree with, but there are no hard-and-fast rules in assessing software, that you can say avoid this or avoid that at all costs, because there are very few perfect programs, and... we've found... that a program which is, to all intents and purposes, not a good program at all for the intention of what it was designed,... we can often find another use for it, which maybe even the fella who wrote it hadn't even thought of, and as such, you can't condemn it out of hand, so we keep a very open mind on software, and we'll always try it with children and then see what they get from it, and then decide, right, where does this fit in with our scheme of things?" (Bi7).

The Headteacher thus indicates another source of non-correspondence: teachers may use software in ways that the designers had never intended. Since this is so, it is simply unjustifiable to imply an interpretation of computer education from an examination of the school's software collection alone.

6.4 Summary And Conclusions.

Headland and Ben Mercy used the computers differently. However, it may be seen that both schools' interpretation of computer education, as implied by the software mostly used, was, to some degree, at odds with the interpretation really employed by the teachers, as revealed by what they did and said. To some exent, what the teachers were doing with the microcomputer at Headland school was similar to what the Ben Mercy teachers were doing, in the sense that both schools were going through an exploratory period, at the time of the research. However, it was also clear that at Headland, little thought was being given to the idea of computer education. At Ben Mercy school, under the direction of the Headteacher, attention was being focused on the educational purpose of the microcomputer, although it could be said that this school too was at an exploratory stage. Because of this, and because neither of these schools had explicitly adopted a particular interpretation of computer education, it is extremely difficult to say that the microcomputer was, or was not, improving the quality of educational processes, although the feeling is that at Headland school it was not (and will be unlikely to in the future if not more thought is given to its educational value), and at Ben Mercy school, at times it was. How schools build on this exploratory stage will, of course, be vital for the future of computer education in the primary sector. This concern is taken up in Chapter Nine. Next, however, attention turns to the third case study school, Longsight.

Chapter Six: Notes.

Software At Headland.

Disk 1	Disk 2	Disk 3	Disk 4	Disk 5
Anag	Crash	Alpha	Brickup	3w
Build	Frac	Spiders	Gates	Bomber
Eureka	Mquiz	Caland	Spmain	Boxesi
Snap	Quiz	Europe	Vennkid	Chains
Testc	Shping	"A"	Watchp	Findme
Trains	Diet	Letgrab	Cat&Mse	Map
Box	Litter	Number	Shape	Spstar
Ergo	Multds	Bottles	Symmet	Supermn
Morless	Shapeb	Witch	Vennman	Add/let
Spike	Table	Make37	Wshape	Bondsta
Time		Wdworm		Bull&co
				Countrs
				Godown
				Spots
				Story
				Wdmatch

Rally A and Rally B (Ladybird-Longmans): sums + - x /

Basic Number Help A and B (Ladybird-Longmans). Wilt (Longmans). Globe.

Add-Take. Doomsday. Disk of games, including "Hopper".

Welsh Programs (some translations of Disks 1 - 4)

Ask Programs: "Number Chaser", "Children From Outer Space", "Table Adventures" (this latter contains: "Shooting The Rapids", "Underground Escape", "Rainbows End" and "Number Families").

Software At Ben Mercy. (incomplete list)

M.E.P. Micro-Primer programs

Edword chip

Welsh Logo chip

Quest

Display Data

Air Brush

Developing Tray

Note Invaders

Number Painter

Number Chaser

Infant Letter

Infant Number

Front-Page

Flowers Of Crystal

Pirate

Viking England

L-Mathemagical Adventure

Dragons' World

Mary Rose

Granny's Garden

Adventure Island

Chapter Seven: LONGSIGHT, LOGO AND COMPUTER EDUCATION.

7.1 Introduction.

The focus of this chapter is Longsight school and the use of Logo. To some extent, this chapter follows the format of Chapter Six: firstly, the history and organization of computers at Longsight school is briefly considered, but, as with the other schools, the main attention centres on whether there is a correspondence or discrepency between Logo, and the philosophy and claims made for it, and the school's interpretation of computer education. The Chapter also includes an extensive report of two pairs of pupils' work with Logo, the intention being to show both the way in which Logo was used in the school, and to go some way towards assessing its value in the primary classroom in general, and its appropriateness to Longsight school in particular.

The fieldwork at Longsight was different in nature to that carried out at Ben Mercy and Headland. The work at Longsight was mainly concerned with studying children learning the programming language Logo, over a two year period. From January to July 1985 I worked with the entire third year Junior class. Visits to the school were made two days a week, during which time groups of four pupils came to a small "computer room" (housing one BBC and one Apple II computer system) where they were introduced to Logo. Over this period they were able to benefit from several hours of hands-on experience and reach the level where more creative and challenging things could be done with Logo. For the third year Junior pupils, I became their Logo teacher. The main data gathering period at Longsight was November 1985 to April 1986: this time I was less a "teacher" and more an "observer" and gathered information on two pairs of children, then in Standard 4 (fourth year Juniors).

7.1.1 Computers At Longsight.

The school acquired its first computer in 1981. In the words of the Headteacher:-

> "... the visual aids officer visited the school and persuaded me that the ZX81 was a good buy and would be of great benefit to the school." (Li1).

However, although the first purchase "broke the ice", it turned out to be disappointing and now remains in a cupboard gathering dust. Yet, despite this disappointing introduction to computers, the school took advantage of the match-funding scheme and acquired a BBC micro, colour monitor and cassette-player in 1983/4. Programs on tape proved unsatisfactory and so later a disk-drive was acquired. During the main fieldwork period the school had the use of two BBC computers, colour monitors and disk-drives which were set up in the corner of the fourth year Junior classroom. The Standard 3 teacher also introduced his class to Logo and had two computers set up in a large walk-in storeroom. The extra equipment was on loan from the University (U.C.N.W.).

The school got involved in this Logo project as a result of the Headteacher's attendance on a half-day course run by U.C.N.W.'s Education Department. There he was introduced to Logo and asked if his school would like to participate in a project being initiated by Dr. Terry, and, in the Headteacher's words:-

> "... this I was only too ready to accept because any... extra expertise in the school I think is an asset." (Li4).

Apart from Logo, the computers were used for little else. The school had all the M.E.P. introductory software and the odd simulation ("Flowers of Crystal"), but most energy was directed to the Logo work with the upper Juniors. Other teachers and pupils at the school were not involved with computers. During 1986 the third years also followed a television series entitled "The Micro at Work" and made some use of the accompanying software.

This school, with its concentrated work with Logo illustrates how one particular avenue of computer education may be followed and explored. Its concentration on Logo alone makes it a very different case from the other schools. It could be said to exemplify a third approach to computer education.

Just as the "correspondence" question was considered for Headland and Ben Mercy, it now needs to be considered for Longsight school: "does the Conjectural interpretation of computer education (with emphasis on forming and testing hypotheses) implied from the software used (i.e. Logo), correspond to the teachers' own interpretations?".

As has already been explained, this school devoted its microcomputer work to the computer language Logo, Thus, in order to answer the above question, it is first necessary to explain what Logo is and examine its philosophy so that it can be appreciated how its use would indicate the conjectural approach to computer education.

7.2 About Logo.

7.2.1 Logo: A Programming Language.

In essence, Logo is a computer programming language. It has been argued that it has several important attributes which makes it a good language to learn. Firstly, it is a natural language: Logo connects and builds on what the learner already knows; it does not require any mathematical pre-requisites. Secondly, it is extensible: the language is built up by the learner; using some of the primitives that already exist, the learner is able to define new "words", effectively allowing the language to develop along with the sophistication of the programmer (this is probably one of the more powerful aspects of the language). Thirdly, Logo is procedural: a programming project in Logo is not written as a single monolithic program: instead, Logo is modular in that it allows programs to be divided into small parts. Programs can be written for the parts and then combined together to form the whole program. Lastly, Logo is interactive: the effects of the commands are immediate, and visible (in turtle graphics). As a programming language, Logo can claim to have genuine educational value because it is easy to learn and easily expanded, and additionally, the vocabulary reflects important programming concepts like variables, recursion, subprocedures and editing.

The most well-known aspect of Logo, and that which is most appropriate to primary education, is "turtle graphics". The turtle can take one of two forms: either it can be a robotic device, (the "floor turtle"), which, when linked up to the computer, can be given commands to move around and make drawings: or it can be represented on the screen (the "screen turtle"), usually by a small triangle. In either form, the turtle responds to commands given to it by the programmer. If commanded to move forward or back a given amount, it will do so, leaving a trail behind, if the "pen" is down; when instructed to turn left or right a given degree, it will change its heading accordingly. Hence, the turtle can be instructed to draw a square, for instance. Children can direct the turtle around and create picture and designs. Programming the computer amounts to teaching the turtle a new word. Children do not think of writing a program, rather they think of teaching the turtle new commands made up of the commands it already knows. As Papert (1980) explains:-

> "The idea of programming is introduced through the metaphor of teaching the Turtle a new word." (p12).

So, for instance, the turtle could be taught the new command SQUARE (or SQ or whatever name the child wished to use). A definition for SQUARE would have to be given. This would be done by writing a procedure, or little program, such as:-

```
TO SQ
REPEAT 4 [FOWARD 100  RIGHT TURN 90]
END
```

SQ is made up of commands the turtle already understands. Turtle has been given a new command, SQ, and SQ can now be used in other programs. The turtle makes the programming activity more concrete. Indeed, children will often identify with the turtle and experience the commands themselves, which is known as "playing turtle".

7.2.2 **Logo: The Philosophy And Claims.**

The main inventor of Logo, Seymour Papert, claims that it is more than just a programming language, it is a philosophy of education. It has been recognised (by Dreyfus and Dreyfus, 1984, amongst others) that Papert appreciates that the use of a computer in education needs to be based on some theory of how learning takes place, and he is one of the few who has worked out an explicit theory of the educational value of a computer application (Logo), which he has expounded in his book Mindstorms: Children, Computers and Powerful Ideas (1980).

Papert theorizes that the reason why so many people are fearful of mathematics is because our culture does not encourage mathematical investigation. Take for example, the conservation of liquid volume (i.e., if water is poured from a long, thin vessel into a short fat one, the volume of water will remain the same). Children find the conservation of volume a problem, or rather, <u>some</u> children find it a problem; there are cultural differences in that chidren from a "water-slopping" culture do not find it a problem. So, Papert argues, children's ability to perform Piagetian tasks is partly dependent on their cultural environment. [The Logo philosophy is underpinned by Piaget, but Papert claims that Logo makes it possible for children to "concretize" formal operations long before Piaget suggests (11 to 12+ years)]. Papert believes that computers, using Logo, have the potential to provide a rich mathematical environment. In <u>Mindstorms</u>, Papert puts forward his vision of a new kind of learning environment in which children use Logo as a natural vehicle for exploration and discovery in a computer rich culture. In learning Logo, Papert argues that the pupil is put in touch with powerful thinking and problem solving ideas: the children learn more than simply a programming language. He argues that Logo allows children to become mathematicians, that children develop a mathematical way of thinking by "doing maths". Through investigating the turtle graphics "microworld" (an exploratory learning environment), children experience real mathematical concepts (for example, simple ones like estimation of distances and angles, through to more complex algebra and symbolic representation involving the use of variables and conditionals), so providing them with a powerful way of interpreting their environment. Further, Papert claims that learning Logo develops problem solving skills. A procedural thinking approach to problem solving is encouraged. Children discover that their big problems can be broken down into smaller ones which are easier to solve. Working with turtle graphics, they come to realize that their large, often complex designs can be more easily drawn on the screen if they are broken down into smaller parts; these can then be combined together to form the whole. One of the most important ideas in problem solving is that of breaking the problem into a set of smaller, more easily managed problems. It is easier to "de-bug" shorter procedures (each of the parts can be tested independently). Thus, splitting up the problem and writing short procedures to solve the simpler problems, is easier than writing one long procedure.

When writing programs in Logo the programmer is encouraged to go through the following sequence:-

(1) Analyse the problem.

(2) Break it down into smaller sub-problems.

(3) Write a program.

(4) Run the program.

(5) De-bug the program.

This problem solving strategy may be utilized in many situations. Papert says:-

> "Turtle geometry... is an aid to learning other things because it encourages the conscious deliberate use of problem solving and mathetic strategies... Polya has argued that general methods for solving problems should be taught... Polya recommends that when ever we approach a problem we should run through a mental check list of heuristic questions such as: Can this problem be subdivided into simpler problems? Can this problem be related to a problem I already know how to solve? Turtle geometry lends itself to this exercise." (1980, p63/4).

Logo can introduce problem solving into the curriculum. Children begin asking questions of the sort, "Why don't we try...?" "What happens if...?" "Why did that happen...?" They begin hypothesising, planning, experimenting and assessing/evaluating i.e. utilising the "scientific method". The scientific model of problem solving has been linked with the social reconstructionalist progressive view of education, and particularly with Dewey. Thus, using Logo in the primary school may be seen as supporting a progressive view of education. Such a connection, of course, is also indicated by the association with the Conjectural paradigm.

The de-bugging aspect of the scientific problem solving strategy is of further note: learning through Logo, children discover that it is not important, or often possible, to be right the first time. Programs frequently have errors or "bugs" in them which can be corrected by a process of de-bugging. Correcting errors is seen as an important part of the learning process. There is no shame or embarrassment at being wrong (or rather, not quite right) the first time - even the best programmer often finds bugs in the first run of a program.

The development of problem solving strategies is one of the more important claims made for Logo, and a claim which clearly identifies Logo with the Conjectural paradigm. However, of no less importance is Papert's argument that learning Logo develops certain other intellectual skills. He argues that the child learns by doing and then reflecting on what has been done. The exercise of Logo programming exposes the child's thought processes in such a way that "thinking about thinking" can occur. The extensibility of Logo allows new "words" to be defined for the turtle, thus children teach the turtle how to "think," and as a result, explore the way they themselves think. Papert (1980) claims that teaching the child how to program the computer can be done in such a way that programming teaches the process of thinking itself:-

> "Even the simplest Turtle work can open new opportunities for sharpening one's thinking about thinking: Progamming the Turtle starts by making one reflect on how one does oneself what one would like the Turtle to do. Thus teaching the Turtle how to act or to 'think' can lead one to reflect on one's own actions and thinking." (p28).

Working with turtle graphics, unlike using a pen and paper, confronts the learner with the problem of expressing precisely and mathematically what has to be done to draw a certain shape. This makes children think about what is being done so fostering the ability to express thoughts accurately and precisely.

In addition to these thinking skills, Logo is reported to foster qualities in attitude to work, namely, discussion, motivation, self-confidence, co-operation and collaboration. Children working in groups are often forced to justify their decisions about their Logo plans, to one another (that is if the group works well). Such discussion promotes language skills; Logo's usefulness is not confined to mathematical areas of the curriculum. Indeed, a Welsh version of Logo has been developed and its use in schools is planned to promote the Welsh language.

The Logo environment embodies a particular view of education. There is an emphasis on discovery and exploration with the learner <u>actively</u> exploring ideas, rather than passively absorbing facts. Papert (1980) recommends a guided-discovery, child-centred approach to the learning of Logo. He comments:-

> "In most contemporary educational situations where children come into contact with computers the computer is used to put children through their paces, to provide exercises of an appropriate level

> of difficulty, to provide feedback, and to dispense information. The computer programming the child. In the Logo environment the situation is reversed: The child... is in control: The child programs the computer." (p19).

Papert (1980) also voices a certain view of the curriculum which has implications for the teacher. He states:-

> "Logo can help in the teaching of traditional curriculum, but I have thought of it as a vehicle for Piagetian learning... which to me is learning without curriculum... But 'teaching without a curriculum' does not mean spontaneous, free-form classrooms or simply 'leaving the child alone'. It means supporting children as they build their own intellectual structures". (p31).

The idea of "learning without a curriculum" has implications for the role of the teacher. Rather than instructing, the teacher is recommended to support or guide. However, Papert also recognises that Logo can help in the teaching of a traditional curriculum, that Logo may be used in ways which are at odds with the philosophy. This form of non-correspondence will be taken up later.

In summary, Noss (1984) justifies Logo on the following grounds:-

(1) It provides concrete justification for the use of formal language and rigour.

(2) It offers an environment for an experimental approach to mathematical ideas and processes.

(3) It offers a context and language for modelling heuristic concepts such as planning, de-bugging, testing, and such like.

(4) It allows insight into key mathematical ideas.

The concrete and natural features provide children with a tool for modelling mathematical ideas and heuristic concepts, such things which are emphasized in the Conjectural paradigm.

Having examined Logo, its philosophy and some of the claims made for it, it is now necessary to look at Logo at Longsight school.

.3 Logo At Longsight.

.3.1 The Organization Of The Logo Work.

For the main fieldwork period, the fourth year Junior pupils were imetabled throughout the week for their Logo work: every two pairs of upils (grouped on the basis of ability and friendship) were allocated a alf-day session for their micro work, although it was not expected that n entire morning or afternoon should be devoted to Logo. Rather, this arge time allocation made the computer work more flexible for the class eacher.

The Logo work was either based on "guided-discovery" worksheets see the Case Record for examples) or on pupils' own Logo "projects". The guided-discovery" worksheet "Sessions" were particularly useful in the arlier stages, especially when new ideas were being introduced. dditionally, when the class's work was based on "worksheets" it was asier to have some idea about what the pupil was trying to achieve, and o assist those who needed help. This was not so easy when pupils were orking on their own designs. However, it was clear that as children's roficiency increased, so did their desire to work on more lengthy Logo projects". Some children liked to work on their own designs; others had ifficulties thinking up designs, but were pleased with the opportunity to xtend a suggested drawing. Such project work tended to be more fruitful nd rewarding.

During this main fieldwork period at Longsight I spent every Monday t the school. For this time, two pairs of children were closely studied. upils came to the computer corner in two pairs (one pair for each achine): in the morning session, attention focused on the case study irl-pair, and in the afternoon, the boy-pair. Since I was at hand to ssist four pairs of pupils on Mondays, those pupils were instructed to elp their classmates during the week, if assistance was requested. dditionally, within group co-operation was encouraged. This arrangement reed the class teacher from any involvement in the work. The pupils knew hat to do and who to call on for assistance. It seemed, from looking at he pupils' books, that this arrangement functioned since there was sually evidence of recent Logo work. Yet, on a number of occasions, everal pupils asked if they could "have a go" that day, claiming that hey had not used the computer all week (Lf136).

Now that the way the Logo work was organized at the school has een briefly outlined, it can be considered whether or not there is a iscrepency between Logo, and the implied interpretation of computer ducation, and how it was actually used in practice, with a view to ssessing whether such computer use enhanced the quality of the ducational processes. To this end, the curriculum policy and the eachers' words and actions will be considered.

.3.2 The Curriculum Policy.

When the curriculum policy document is studied, it is apparent hat some of the recommendations for the approach to teaching particularly mathematics and science) are in tune with Papert's ecommendations. For instance, regarding certain "important mathematical rinciples", it is stated that:-

"concrete experience must precede abstract thought." (Lcp18)

urtle graphics would clearly fit in with such work: Papert (1980) has aid that children learn by doing and then reflecting on what has been done. Elsewhere in the document, one of the aims of mathematics is said to be:-

> "to encourage the development of a healthy inquisitive attitude towards mathematical patterns and structures." (Lcp19).

Using the computer for Logo would (according to Papert) encourage such an attitude. The appropriateness of Logo for this school is also apparent if policies regarding primary science are considered. The policy document states that scientists are constantly observing, questioning, experimenting and generating ideas and the Headteacher recommends that the "let's find out" and "I wonder what will happen if..." attitude should be cultivated by the staff (Lcp71). He states:-

> "The essential characteristic of education in science is that it introduces pupils to the methods of science". (Lcp74)

Among such methods he includes observation, suggesting explanations, testing explanations... all of which Logo work is said to encourage.

However, these are the stated policies and it is possible that practice may differ. Additionally, the policies themselves are not exactly homogeneous. For example, from the document, it seems that the Head considers the following an important mathematical principle:-

> "Children revel in a few minutes of quickfire mental work with no written answers. Make time for it everyday." (Lcp18).

Yet, extracts from the Cockroft Report are also included, and at one point it is written that:-

> "practice in computation, undertaken by itself so often produces no improvement in the ability to make use of mathematics in everyday situations."

Maybe there is not a conflict of views here, but there is the possibility. To clarify this, what the teachers actually did and said will be considered.

7.3.3 Teachers' Words And Actions.

For the fieldwork period at Longsight, three teachers were in some way involved with the computers, namely the Headteacher and the third and fourth year Junior teachers. The third year Junior teacher was introducing his class to Logo. The previous year his class had been involved in the Logo work and this had stimulated his interest in it. However, he expressed some management problems that were reiterated by the Headteacher. They both were of the opinion that Logo was very difficult to use in the classroom without some support; this could come in the form of a student on teaching practice who might free the class teacher for Logo work with groups of children: the third year Junior teacher found it problematic working with Logo without this help. The Headteacher at one point intended involving a retired Headteacher in the locality who had volunteered his help in the school. It was thought that he might introduce some children to Logo, but in actuality, this plan did not come to fruition.

As for the fourth year Junior teacher, despite the Logo work carrying on in a corner of her classroom, she remained relatively uninvolved. The Headteacher commented that:-

"she's not too confident with computers." (Lf5).

However, as far as the project was concerned, this teacher's lack of involvement was not problematic since the arrangement was such that the children mostly worked on their own.

The fourth year Junior class teacher did not appear to place high priority on the Logo work. She rarely overtly showed interest in the children's computer work: she did not "interfer," but did not seem particularly curious either (Lf53/4). The project did not seem to affect her: she freely gave access to her class and pupils and was happy to co-operate in this respect but preferred to remain uninvolved in the project. Despite this she did comment that the computer work helped the pupils and that even the "slow" ones were able to cope with it and did not need pushing (Lf145). (Here there is the possibility that she mistook keenness for ability, since most pupils experienced problems of a varying degree). Also, she was aware of the pupils' enthusiastic response to computers, on some occasions threatening children with "no computers" if they failed to get on with their work or be quieter (Lf7).

The Logo work in the fourth year Junior class was not linked to other areas of the curriculum, although this is clearly possible; more formally it could be linked to mathematics work on angles, for example, less formally, to project work (for instance, a project on castles could involve children designing castles and drawing them on the screen).

As has already been mentioned, the third year Junior teacher did get more involved, continuing the Logo work after the first year of the project. This interest stemmed from the teacher himself since no greater effort was made to involve him more than the fourth year Junior teacher. In fact it might have been less likely that the third year Junior teacher became involved since his class were initially introduced to Logo in a separate "computer room". The Logo work in the fourth year Junior class actually took place in a corner of the classroom - an awareness of the work could not be avoided.

Perhaps the reasons behind the fourth year Junior teacher's lack of interest in Logo should be explored. There might be a mismatch (or non-correspondence) between her teaching style and that implied by Logo. Or it might be that her lack of confidence with microcomputers is sufficient explanation. The Headteacher's relation of the staff's initial reactions to the computer provides some clues. He said:-

> "I think they thought it was just a luxury and something that wasn't for them... The staff didn't show a great deal of interest in the BBC when it first came - it was a little bit of a marvel - something mysterious to them in school - something that someone else used and not them... they had a fear of the unknown." (Li2).

This in itself is not an unusual reaction to the new machinery. However, the Headteacher spoke of his difficulty to surpass this initial reluctance. He discovered that persuading the staff to use the computer was no easy task, and of the teachers that did use it in their classes (the third and fourth year Juniors), he commented:-

> "whether they have full confidence in what they're doing, I'm not too sure." (Li3).

He was aware that even teachers of classes which did use the microcomputers (almost solely for Logo), still felt somewhat apprehensive. The Headteacher was keen to increase the children's use of the computers but found it difficult to encourage the staff. He said that they wanted to use the computer for things that they could not otherwise do (a reasonable attitude), but at the same time they were apprehensive and cautious, particularly the older ones (Lf172). Unable to overcome these difficulties, he has latterly resorted to taking children out of classes in small groups and running through programs with them. The other teachers do not make much use of the computer, particularly since the third year Junior teacher departed in 1986 (Lf172).

Lack of confidence may be part explanation for the little use of microcomputers made by the staff, outside the Logo work initiated by the project. As has already been mentioned, the fourth year Junior teacher's lack of interest in Logo may also have been due to a mismatch between her teaching style and that implied by the Logo philosophy. The fourth Year Junior class was taught along fairly traditional lines with a subject based curriculum. The pupils used separate books for mathematics, graph work, English, Welsh, poetry, scripture, geography, nature, history and science. Some project work was carried out (for example, on birds), but much of this involved copying drawings from books and writing about them in a factual fashion (Lf53). Little group work took place. The fourth year Junior teacher was aware of the need to prepare (academically) the pupils for secondary school. However, this is not to condemn this teacher's methods (which no doubt best suited her) for indeed, she had a good relationship with the children, could clearly "keep order", but at the same time indulged the use of the children's nicknames. Additionally, she was not overtly keen on standardized tests (in reading and mathematics for instance); no results were available upon request, although she responded positively to the suggestion that I should administer one. Thus it would be inappropriate to classify her style as simply "traditional", yet it is fair to suggest that her general approach to teaching is at odds with that proposed by Papert. Even if this teacher, at a later date, decided to use Logo in her class, it is probable that the teaching style, implied by the software, would be distorted. This is a form of non-correspondence alluded to earlier. To explain, it is possible to use Logo in a very instructional fashion, at odds with Papert's recommendations; discovery and exploration could easily be replaced by direction and instruction. [The amount of intervention is indeed problematic - too much can turn the Logo environment into a didactic and passive one; not enough, and the children can become frustrated]. This realization is further evidence of to the danger of assuming a certain attitude towards computer education from the software used.

The Headteacher's attitude towards computers in the primary school was different. He frequently made the point that children should be aware of microcomputers in their everyday lives. Commenting on the staff's reaction, he said:-

> "I think a lot of it is sort of fear - just as many have fear of things like tape recorders, projectors. They think of these as sort of luxuries... things that they don't really need and I think that they look at the computer in the same sort of light, but I think that it's completely different... the computer is something we're living with." (Li15/16).

Longsight's Headteacher believed that it is the duty of the teachers to increase the pupils' awareness of computers in their everyday lives. He stated:-

> "I would like to see most children aware of what the computer... can do - not only in the school situation but also in the home... how the microchip is affecting our everyday life... It's important that children are aware of the uses of the computer and we shouldn't neglect this duty... I feel very strongly that children should be aware of all the possibilities of the computer, not just one or two." (Li13/14, 16, 18).

This concern with the effect of the microchip technology was reinforced by the television series followed ("The Micro At Work"), although it is possible that the programme affected the Head's attitude and sparked this concern with everyday awareness of computers. The Headteacher commented that the television programmes:-

> "related the computer to everyday life and I think this is what is important... we're handling micro-processors all day long - in the home, on our wrists, as calculators in the classroom and... this is

> the sort of world we're living in now and I think children... the sooner they come to terms with it - what it's all about, I think, the better." (Li10).

These remarks are perhaps surprising coming from the Head of a school devoting its micro use to Logo. But the comments were made after the two year Logo project, and perhaps the Headteacher thought it was time to explore other computer avenues. He expressed certain desires of this nature. Speaking of the different computer applications, he commented:-

> "I would like to develop it in more ways than just drill-and-practice... Logo is one route we could take, and the other I want to develop is the computer as a word processor - I think this has tremendous possibilities, even at primary level." (Li9).

An interest was also expressed in information processing and the idea that children should compile their own data files (Li9/10). When asked about adventure-game type programs, he mentioned "Flowers of Crystal", saying:-

> "I haven't really tried it with children yet, but it's full of possibilities... as a lead in lesson for a project... The children are put into thinking and problem solving situations and arising from this you've got all sorts of spin-off activities... art and craft, maths - co-ordinates... there's a tremendous amount of work one could use just starting from this basic program." (Li10/11).

Longsight Headteacher showed an awareness of the diverse uses of micros. Despite his awareness of the benefits of Logo resulting from the project work, he is open to other computer applications. However, of the Logo philosophy in general, the Head confessed "off the record" that he didn't know anything about it. From time spent in the school the impression was formed that the Head was more concerned with seeing that the computers were used, rather than in the philosophy of the programs. In this sense, there is a non-correspondence in that the Conjectural paradigm implied by the use of Logo was not explicitly adopted. This conclusion will be explored later, but for now, I turn to an examination of Logo in action.

7.4 Logo In Action.

The next section will be given over to reporting the Logo experience at Longsight school, by concentrating on the two pupil pairs. It is hoped that this will show both the way in which Logo was used in the school and go some way towards assessing its value in the primary classroom in general, and its appropriateness to Longsight school. In order to do this, it is first necessary to introduce the pupils concerned.

7.4.1 Logo Pair One: Lisa and Everlyn.

7.4.1.1 Lisa And Everlyn: Pupils Profiles.

When the third year Junior teacher heard that Everlyn had been selected for close observation, he told me, light-heartedly, that I was asking for trouble (Lf5). Everlyn is a real chatter-box! She is as confident and relaxed talking to adults as she is to her peers. She will engage in almost gossipy chatter if given a listening ear. Words to describe her include sociable, lively, friendly, and out-going. As her English exercise books show, she expresses her own opinion where possible.

In comparison, Lisa is more reserved, although not shy. Her personality is less easy to pin-down, despite it being strong enough not to be over-shadowed by Everlyn. In her work, Lisa showed determination, although as the year progressed, the class teacher expressed concern over her social relationship with a rebellious girl, voicing the fear that her work might suffer. This other girl had a "couldn't-care-less" attitude and it was feared Lisa might adopt it. It did seem, on looking at Lisa's maths books for example, that her work was deteriorating: comments had changed from "good neat work" to "untidy" and "this is not your best work". However, this decline was not in evidence in her Logo work, in which she showed perseverance. Everlyn was the one who was more easily distracted. She lacked the ability to concentrate over a period of time. She also had a tendency for moodiness which affected her work: on "good" days she showed great resourcefulness; on "bad" days, irritation and frustration.

As a pair, their characters were complementary. When Everlyn became restless and ready to give up (as often happened when programs needed de-bugging) Lisa's example of patience and methodical work encouraged her. Lisa was a plodder who would stick to the task. She would often nudge the more volatile Everlyn to bring her back to the task in hand. Their communication was generally good, although at times it was difficult to distinguish discussion from argument. When not working co-operatively, Lisa tended to do all the thinking, whilst Everlyn simply acted as the typist. Sometimes Everlyn could be bossy saying such things as, "let's do it my way". Lisa sometimes gave in reluctantly but at other times, worked hard to convince Everlyn that her way was better.

From the results of a graded arithmatic test (Vernon, P. E. and Miller, K. M., 1976) given mid-way through the fourth year, both were assessed as having a maths age in excess of 12 years 3 months. Lisa and Everlyn respectively scored 46 and 50 out of 70 (the highest scored was 57, the lowest, 20; a score of 32 was equal to a maths age of 11 years). It was surprising that Everlyn's score was so high; especially surprising that she scored higher than Lisa. She did not overtly show such ability in maths. She did not rate the subject as a favourite; her favourite was English. Her general attitude was "happy-go-lucky"; she did not strive after high results. Her class teacher thought that she could do better, explaining that "she doesn't apply herself". Of Lisa she said "she works to her capicity" (Lf48). This opinion was reflected in the star allocations (awarded for good or improved work or behaviour): by the second term, Everlyn had gained five stars; Lisa seven (the highest number awarded was eleven; the lowest none). However, it was clear from Everlyn's exercise books that she was improving, both in terms of accuracy and neatness. As an example, in her "sums" book, at the beginning of the year, the class teacher was commenting, "concentrate on your work Everlyn", whereas later the comments were encouraging, "neat work". Indeed, when I asked to see her books, Everlyn said that she wished she could rip out the early untidy work, but consented that at least it showed improvement. She was generally pleased to show me her work. Lisa on the other hand, was nonplussed. Lisa also said that she did not have a favourite subject as such, but did like history and geography (two of the neater books), and maths. She thought English was just "okay".

The following instance should illustrate the approach taken to Logo and the girls' interaction.

In the girls' Logo work, procedures are written. A brief explanation of this was provided earlier (page 184). The example used was a procedure for writing a square. A note on the more common Logo commands can be found in the notes section at the end of this chapter{1}.

7.4.1.2 **Lisa and Everlyn: Example of Logo Work.**

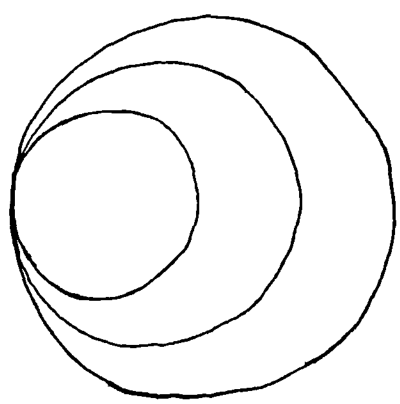
The illustration chosen is based on the girls' work on circles. In Logo, a circle is made by going forward a little, turning a little and repeating this lots of times. In the session before those to be outlined, Lisa and Everlyn had worked on changing the size of circles by altering the number of repeats together with the angle, rather than simply changing the forward amount. This exercise drew attention to the relationship between the number of repeats and the amount of turning. The relationship is that the repeats multiplied by the turning is equal to 360, for a full circle. 360 is the number of degrees in a total turning; to draw a circle, the turtle must move through the whole 360 degrees. From this work it was found that both the following commands draw circles:-

```
REPEAT 90 [FD 3 RT 4]      and      REPEAT 45 [FD 3 RT 8]
     (90 x 4 = 360)                      (45 x 8 = 360)
```

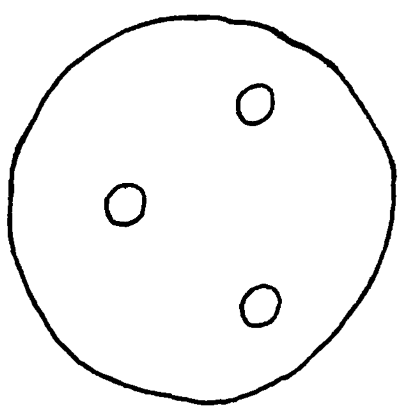
The girls were able to see that these circles were not the same size despite using FD 3 in both cases. Some readers may spot that these are not, in fact, circles: the first draws a ninty-sided shape with each side having length 3, and the second a forty-five-sided shape also with a side length of 3 steps. However the graphics are not of high enough definition to distinguish each side of these so-many-sided shapes; what appears is a circle.

With this grounding, Lisa and Everlyn were set the following problem:-

(A)



(B)



1. Write in your books the procedure you think will draw the design.

2. Try it out on the computer.

3. De-bug if necessary.

4. Write down any problems you have.

In the following pages I shall report how Lisa and Everlyn tackled this problem, the difficulties they encountered and how they interacted with one another (Lf24 to 27; TAPE No.2:Side A [T2A]: Case Record p133 to 157).

At the start of the session, the girls have difficulties recalling the commands needed to draw a circle. They look back at their last session's notes. Working together, they write the commands for the first design (A) in their books. They both write the following:-

```
TO TUNNEL
REPEAT 5 [FD 3 RT 72]
REPEAT 40 [FD 3 RT 9]
REPEAT 120 [FD 3 RT 3]
END
```

Each of the three lines of commands in their procedure were lifted straight from the previous session's work. A table had been produced containing different sized circles but each with the same length, FD 3; REPEAT 120 [FD 3 RT 3] had drawn the largest circle. At this stage, the girls fail to notice that the first line of the procedure will draw a five-sided figure with sides three steps long (i.e. a very small pentagon). They discover this later. In the meantime, Lisa announces:-

> "Right then, you've got the procedure. END. Yes, END at the bottom. Right, we'll do a line each" (at the computer). [T2A:CRp137]

This they do although Everlyn repeatedly complains, "can't you go a bit faster!". TUNNEL is defined and they try it out. Their procedure draws two smallish circles, one larger than the other, and a very small pentagon, not much larger than a dot. The following conversation ensues:-

Everlyn: A bit small don't you think?

Lisa: No, it's not.

E: Eh?? We did three Lisa! [Pause]

ADB: Do you want to watch it again?

E: Oh, it's...

ADB: What do you think?

E: There's a tiny dot there. I don't get that!

ADB: You have a look at your procedure - edit it again (to show the procedure on the screen)

E: EDIT space (....)

L: TUNNEL (....)

E: Oh I don't get that! We've done three and it doesn't work!

ADB: Do you know what your problem is? Did you watch...

E: I'm doing it all again!!

ADB: What are you going to change?

E: I don't know.

ADB: What's your problem? First of all have a look at that line. What shape does that draw? REPEAT 5...

E: REPEAT 5.

ADB: What does that draw?

L: A circle.

E: Oh! I know what we've done wrong Lisa! 40... Oh no. That goes into... 40 goes into... 40 goes into 360 nine times.

ADB: That's right, that's right.

E: That's right.

ADB: What does <u>this</u> draw? REPEAT 5.

E: 3 goes into... 5 goes into... 5 times 72

ADB: is? You don't have to work it out, just tell me.

E: I don't know.

ADB: Yes you do.

L: Five 72s

ADB: Yes. Four 90s, three 120s...

E: 360.

ADB: Yes, but <u>look</u> at it! REPEAT <u>5</u>.

L: REPEAT 5 times.

ADB: What shape does that draw? This is a shape with 5 sides.

L and E: Ahhh... Oooooh...

L: It draws one duh duh duh duh... like that.

ADB: And you know how big the turtle steps are - very tiny, and you've got 3.

L and E: Oh yeah!

ADB: So what does this draw then?

L: A small...

ADB: A <u>very</u> small...

L: Circle.

E: Hexagon.

ADB: No, not a <u>hex</u>agon...

L: 5 sides.

ADB: What's got five sides?

E: Octagon.

L: No, that's eight.

ADB: Do you remember?

E: Heligon... polygon...

ADB: Nearly right.

E: Polygon.

ADB: (to the nearby pair - A and M - working at the computer) What's a five-sided shape called?

A and M: Pentagon.

ADB: That's right.

L and E: Ooohuh.

E: You would get it! [T2A:CRp138-140]

Lisa and Everlyn simply could not see the wood for the trees! They had doggedly fixed their minds on circles, so much so that they simply could not see that REPEAT 5 [FD 3 RT 72] was drawing a very small pentagon, even though they had drawn many pentagons in the past. Their minds were closed to anything other than circles. They had to be coaxed to the realization that it was, in fact, a pentagon, and an extremely small one at that. The extract also shows a difference in reaction to the problem: Everlyn is quick to express her lack of understanding, with the words "I don't get that", but rather than work towards an understanding she rashly resigns herself to "doing it all again". Lisa on the other hand is much less vocal, and much less rash in her judgements.

This extract also raises some questions about the role of the "teacher". Reading the conversation in isolation, it might seem that the "teacher" was too ready to assist and did not give the girls enough time to confront the problem. Knowing when to intervene is an ever-present problem. However, although this event may be criticized as too "teacher-directed", it should also be noted that Everlyn is ready to resign herself to starting afresh rather than work out what is going wrong (although this in itself may lead to a solution to the problem). The amount of intervention is a disputable issue in Logo.

Having comprehended at least part of the error, they continue with the work. TUNNEL is edited and the pentagon replaced with REPEAT 15 [FD 3 RT 24] (again lifted from previous work). This effectively solves the problem: it draws three circles of different sizes. However, all the circles are particularly small and disproportional to each other. I ask if they can improve it:-

ADB: Do you think you could make it better?

E: No.

ADB: You think you could<u>n't</u>?

E: No.

ADB: That's a bit defeatist, isn't it?

E & L: Yes. [T2A:CRp141]

I ask them what they could simply change in the procedure to make all the circles larger. Everlyn grasps it, saying:- "change the number of steps!" Knowing this is easy, they edit TUNNEL and change each FD 3 to FD 20.

L: I've done it.

E: Hopefully...

L: Will it fit on the screen? (The largest circle does not).

E: Ooooh.

L: Shouldn't have done the last one. Change the last one to... 10. Yes because it's too big.

E: Do it to 15 now.

L: Not all of them.

E: Oh no.

ADB: What are you going to do?

E: 15. We're going to change them all to 15.

ADB: All of them, or just the last one?

L: Just the last one.

E: All of them.

ADB: Tell me why you say all of them Everlyn.

E: No, the last one I mean...

ADB: Why just the last one?

E: Because the other two fit but the last one doesn't. [T2A:CRp142-3]

Both the conversations so far transcribed show the need for the teacher to check the pupils' understanding. In this extract, Lisa clearly knows what she is doing but Everlyn needs that much longer to compound her understanding of what Lisa is planning to do. Asking the girls to explain their plans clarified their intentions.

The girls carry out their plan and edit the FD 20 to FD 15 in the last line of the procedure giving:-

```
TO TUNNEL
REPEAT 15 [FD 20 RT 24]
REPEAT 40 [FD 20 RT 9]
REPEAT 120 [FD 15 RT 3]
END
```

The result is a much improved design. Both girls are pleased with the outcome:

E: It's better than before.

L: It's still an elephant's eye though.

E: I like it.

L: It's better. (....)

E: It's a masterpiece! [T2A:CRp143]

Any adult familiar with Logo might have expected the exercise to have been completed in a matter of a minutes, especially knowing the work the girls had done previously. Lisa and Everlyn's experience is an example of some of the unforseen difficulties children can get themselves into. They need time to explore their mistakes and consolidate their learning. The teacher has always to walk a fine line between giving too much away and not guiding enough. A teacher is clearly needed in the Logo environment, even when something new is not being introduced; s/he is <u>also</u> needed to guide, encourage daunted pupils and alleviate frustration, amongst other things. But the amount of intervention and the timing are always difficult to assess, and teachers will inevitably make mistakes. Additionally, it goes without saying that careful intervention consumes much of the teacher's limited time.

At this point, Lisa and Everlyn feel discouraged by the difficulties they had had with the first part of the problem, so much so that they are reluctant to move on to the second part:-

L: Oh, do we have to do the other one?

E: No, we've decided no, we don't want to do the other one. [CRp143] (....) We're not doing anything else we've decided. We're not doing that round one. It'll be too difficult.

L: Yeah, because we couldn't do the other one.

ADB: Tell me why you don't want to do that one.

L: It's too hard.

E: It's too hard.

ADB: How do you know? What's hard about it?

E: Getting that in there and using pen-ups and using pen-downs and not knowing where to put them.

ADB: You could draw it on paper quite easily couldn't you?

L and E: Yes.

ADB: If it's so easy to draw on paper, why is it hard to draw on the screen?

L: Because you have to use RT...

E: RT, PU, PD...

L: FD...

E: It's easy to draw on paper.

ADB: ...Just look at the drawing, the first circle. You could draw that because it's just like one of those isn't it?

L: Yes.

ADB: And you could draw a little circle on its own.

L and E: Yes.

ADB: Have a go... have a go at drawing...

L: Do we have to put them in though?

E: Right then, we're going to do BIGCIRCLE, save BIGCIRCLE, LITTLECIRCLE, save LITTLECIRCLE...

ADB: That's a good idea.

E: Then put CIRCLE in the CIRCLE.

ADB: That's very good. So what are you going to do? You're going to define a procedure for the BIGCIRCLE.

E: TO

L: Clearscreen.

E: Bagsy me first. Wait a minute, we have to write it in our books first.

L: Yes, that's a good idea. TO CIRCLE.

E: TO BCIRCLE.

L: Okay, TO BCIRCLE. [T2A:CRp144-145]

And so they continue, although they were initially reluctant. If they thought something was too difficult, they were reluctant to have a go. Everlyn, particularly, preferred to opt out rather than face the challenge. However, once they had been coaxed into actually consid the problem, they soon saw that it is not as difficult as they first assumed. In this instance, Everlyn was especially clear-sighted; she recognized that the problem could be broken down into small parts, a procedure written for each, and then the whole thing put together. The encouragement of this approach to problem solving in the Logo environment was one of the things about which Papert enthused. However, whether or not this problem solving skill is transferable to other situations is a difficult question.

The girls set to work on the problem and write a procedure for the big circle. They note it in their books first and then type it into the computer and check it through. They use the same commands as the big circle in the previous drawing. This gives them:-

```
TO BCIRCL
REPEAT 120 [FD 15 RT 3]
END
```

They then work on a procedure for the small circle. Astoundingly, they again use the commands for a pentagon!

L: I'll do the little circle. TO

E: I know...

L: Small circle, SCIRCL, REPEAT... Repeat how much?

E: Shall we do that one?

L: Repeat 5, FD 20... Right, I've got my small circle. (....)

E: I've got the procedure.

L: Yes, I've got it here. TO SCIRCL... Oh, I've forgotten...

E: Doesn't matter... doesn't matter.

L: I wrote it down there... SCIRCL

E: Repeat 5

L: Repeat 5

ADB: Which one are you using girls?

E: What? No, that will be too small... If you REPEAT 10.

ADB: What shape does this draw?

E: Hexagon, Lisa!

ADB: Not a hexagon...

E: Pentagon.

L: No, not if you've got that thing... Oh, never mind.

ADB: Try it! Carry on Lisa, do what you think. You can always see.

E: Why don't you put 10 Lisa?

L: Because that's what we've got over there.

E: Well? FD 2?!

L: Oh yeah... 20... RT 72... END.

E: Bagsy saving!

L: Okay, wait a minute.

E: I always save because I like putting the disk in. No Lisa!

L: Yes, we've gotta see what it's like.

E: Oh, I thought you were putting SAVE.

L: (groans at the result on the screen) ...think I'll...

E: Forget it Lisa.

L: Edit, edit.

ADB: What's wrong with this one?

L and E: It's too small.

L: Oh, can you move your hand please?

E: TO SCIRCL, REPEAT 5 [FD 20 RT...

L: 50, 50, change it to...

E: No, it's too small then.

L: 50, 50...

E: 50. Oh God! Why did I press RETURN? Right, I'm going to try 40.

L: Right.

E: Delete, delete, 40... it will be twice as big.

L: FD 3

E: SCIRC defined.

L: Oh no, you haven't put FD 3 and 9... Miss, you have to put... She's going like this... REPEAT 40 and left it as it was before!

ADB: What's the problem?

L: She forgot to put that 9 in it.

ADB: She changed the FD, not the number of repeats, didn't you?

E: Lisa...

ADB: Lisa, you see you've got a pentagon because you've got REPEAT 5, so it draws a five-sided figure.

L: No, she edited it... I mean she put 40.

ADB: She didn't change the number of repeats.

E: I only just changed the number of steps!

L: Oh sorry!

E: ...to 40.

L: I thought you were going to change that.

E: SCIRCL. There we go. SCIRCL defined. TO SCIRCL, REPEAT 5 [FD 40 RT 72].

L: Okay.

E: You've done it wrong!

L: I haven't!

E: Not me! [They test it out...]

ADB: Do you know why that drew a pentagon?

L: No.

ADB: If you look at it, what you're telling the turtle to do is draw a five-side shape that has each side 40 steps long. That doesn't draw a circle does it?

L: Oh no.

ADB: What would draw a circle then?

E: Well, if you made that bigger, that number bigger, and changed that number, and made that number smaller.

ADB: Well do that then. [T2A:CRp147-150]

This is another example of the unpredictable mess this pair could get themselves into and, once again, it could be anticipated that without intervention they would have given up on the project (as Everlyn says, "forget it!"). They made the problem very difficult for themselves; firstly they did not spot that the procedure would draw a pentagon. When they got the turtle to draw it they only saw it as being too small, so they changed the FD 3 to FD 40. Lisa seemed confused at this. However, at least having done this, the procedure drew a clear pentagon. Lisa still seemed confused and exactly what was happening had to be explained to her. Eventually, they comprehend the errors and edit their procedure:-

```
TO SCIRCL
REPEAT 10 [FD 20 RT 36]
END
```

The outcome is suitable. At this point, all that remains is to put the design together using their procedures BCIRCL and SCIRCL. However, Lisa becomes irritated by the way Everlyn is treating her. Everlyn has indeed been bossy and quite over-bearing. For Lisa, the last straw comes when Everlyn announces "I've done it!" when SCIRCL is finally satisfactory. Everlyn herself claims the triumph rather than shares it with her partner. Lisa responds in an interesting way (it is to be spectulated whether she intented to teach Everlyn a lesson):-

E: I've done it!

L: Yes I know you have, so then you can fit them in, can't you?

E: What?

L: Fit them in the circle.

E: (laughs) I'll try.

L: Aren't you going to start?

E: Right.

L: I'll wait for you then.

E: Right then. Big circle... B... I've done it in the wrong place.

L: Oh clever! I know what you could have done first. You could have penned-up and then you could have moved over there! Clever!

E: Shut up! Delete... delete...

L: You could draw the small circle first and then you could move over to there and then you could...

E: No Lisa, I'll do it my way!

L: Okay, do it your way.

E: Right then. I haven't done TO anything...

L: (Sarcastically) Arrrhh, you'll have to do it all again.

ADB: Do you need TO yet? Why don't you work at the computer and someone writes it down?

E: Right. Oh Lisa, Lisa, Lisa...

L: I'll write it down! I knew you would say that. What do you want to call it? [T2A:CRp151-152]

A long discussion follows about what the super-procedure should be called. Everlyn starts to get silly. The banter between the two girls shows Lisa trying to highlight Everlyn's silliness:-

L: What do you want to call it?

E: Umm... Everlyn.

L: Everlyn?

E: Everlyn's work!! Huh!

L: Everlyn! Oh, alright, okay.

E: No way Lisa! Call it Hayley!

L: Everlyn Hayley??

E: (laughs) No, just call it Hayley.

L: Why do you want to call it Hayley?

E: 'Cause it will look like her!

L: Very funny. You want to call it Everlyn Hayley...

E: No.

L: ...Lisa, Angela... Do you want to call it all the girls in the class?? [T2A:CRp152]

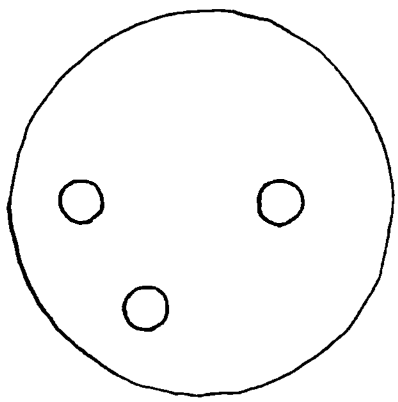
Lisa's annoyance is still in evidence. Before, it seemed that she had resigned herself to writing down the procedure for Everlyn; now she refuses to be amused by a joke she might have shared on another occasion. Lisa simply wants to get on with the work. However, Everlyn's silliness and indecision over what to call the procedure continues and culminates with the suggestion "TO tit-face", to which Lisa responds:-

> "Just get a move on would you?!" [T2A:CRp153] and later,
>
> "Will you get on with it please?!". [T2A:CRp153]

I intervene and suggest that they work out the procedure first, before naming it. They work at the computer, Everlyn typing, Lisa making a note of the commands. Part way through doing this, the bell rings for Break. They finish it off immediately afterwards. The computer had been turned off so it is necessary for them to re-load the procedures they were using; BCIRCL had been saved, but not SCIRCL which has to be typed in again. They then type in the super-procedure (in the end called "?") making a few changes as they go along. The final result is the following program:-

```
TO ?
BCIRCL
RT 90
PU
FD 75
LT 90
PD
SCIRCL
PU
RT 90
FD 300
LT 90
PD
SCIRCL
PU
LT 135
FD 200
PD
LT 45
SCIRCL
END
```

And it draws:-

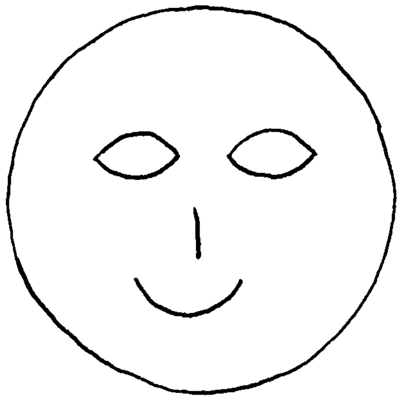


They are satisfied with the result although it is not an exact replica of the design presented. In their own eyes they have succeeded since they saw the problem simply as a large circle containing three smaller ones.

This is the end of the session. The whole session was plagued by the misuse of pentagons which completely confused the girls. The illustration is not an example of their best work. Part of the problem was that because they ran into so many difficulties they tired of the whole work. Everlyn reacted by generally blaming Lisa for the mistakes and by being bossy, and then silly. Lisa, on the other hand, wanted to get the work finished - over and done with as soon as possible. The girls were clearly reluctant to start the second part of the problem, and perhaps it would have been better to have ended their Logo session at this point. However, Everlyn showed clear thinking when talking about how the next problem might be tackled, and it was not anticipated that they would again make the mistake of using pentagons. In order to put their Logo work in greater perspective, it is worth reporting a further session.

As it happened, after this not entirely successful session, the term ended. The girls therefore had a few weeks without Logo before their next session. Their renewed Logo work began with a revision of circles and moved on to explore arcs. In Logo, arcs are simply described as parts of circles, a common one being a semi-circle. It is discovered that, for a semi-circle, the turtle has only to turn through 180 degrees. Thus, the relationship between the number of repeats and the turning is that their product is 180. In the same way, the number of repeats multiplied by the angle equals 90, for a quarter-circle. At the end of this work, Lisa and Everlyn are requested to consider the following problem (Session 12, Lf39):-

TURTLE PROJECT: Write a procedure to draw a face.



Everlyn considers the problem and groans: she immediately thinks it is going to be difficult to draw. I suggest that they could start by writing down the names of the procedures they might write for parts of the face. They take up this suggestion, and Everlyn writes in her book:-

> "First of all define an eye then the line then the mouth and then the big circle around everything".

They decide on the following subprocedures: SCIRCL for the circular eye; BCIRCL for the circular head; NOSE for the line-nose; and MOUTH for the arc-mouth. The super-procedure they call FACE. They anticipate that the super-procedure will be something like this:-

```
TO FACE
SCIRCL
NOSE
MOUTH
BCIRCL
END
```

Once again they see that if the problem is examined more closely it is not as difficult as it first looks. However, there is not time this session to start work on writing the procedures. This is taken up the following week.

The following session is entirely devoted to the face project (Lf49-53; TAPE No.2:Side B [T2B]: Case Record p169-176). Lisa and Everlyn remember that they had begun work on it last week. They start by loading BCIRCL and SCIRCL from their disks as these had been previously defined for use in the circles work. The girls understand that once a procedure has been defined and saved on disk, it can be used in further work. Indeed, their previous diligence has provided them with a good start on the face project. They are clear about what remains to be done and they turn to writing a procedure for the NOSE. This is easy since it is a straight-line nose. Lisa writes in her book:-

```
TO NOSE
FD 50
END
```

NOSE is defined and saved. Everlyn then says "I'll do the mouth" but she has forgotten how to write a procedure for an arc. Lisa cannot remember either. They recall that they had saved a semi-circle the previous week; they load SEMI from their disk. SEMI is drawn on the screen:-

L: Don't you think it's a bit big? Look at the thingy and then make it smaller - the procedure thing.

E: Yeah, it's upside-down though!

L: Yeah, but turn it up-right.

E: How do we do that Lisa? [T2B:CRp173]

They first tackle the problem of making it smaller. As it stands, SEMI is the following procedure:-

```
TO SEMI
REPEAT 45 [FD 10 RT 4]
END
```

The procedure is edited and the FD 10 changed to FD 5 to make it smaller. Everlyn directed this, so I ask Lisa how they made the SEMI smaller:-

L: Changed the steps. (....)

E: That was 10 before.... so I changed it to 5.

ADB: Oh, I see... Tell me, why does that draw a semi-circle?

L: Because 45 times 4 is 180.

E: 180.

ADB: What's special about 180?

L & E: It's half a circle.

ADB: That's right, that's fine.

E: So if you wanted to draw a thing of a circle, a quarter of a circle, you'd have to do 90. [T2B:CRp174]

Unlike in the session previously outlined, both girls now have a good understanding of what they are doing. Next they need to up-right the semi-circle (although Lisa does suggest "you could make it unhappy"). I direct their attention to the starting position of the turtle when it draws the semi-circle; Everlyn immediately spots that it faces up so it needs to start facing down. They quickly and effortlessly edit SEMI and insert RT 180 at the beginning. They want to save the procedure but the error message appears "SEMI already exists". To solve this problem they edit SEMI again and change its name to MOUTH and save that.

Now all the subprocedures have been defined. I ask them what they intend to do next:-

L: Try and put them in the right place: we'll have to make a big (super) procedure now. What shall we call it? (Lf50).

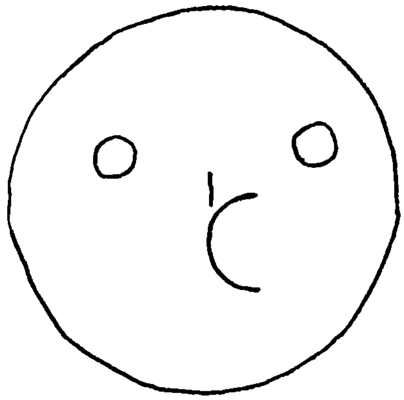
This session shows that they are able to use subprocedures in their work.

Before they begin, I ask them if they want to see the turtle drawing it as they go along; they say they do so I remind them not to define the procedure straight away, rather, work in direct-drive and make a note of the commands as they go along. (Whilst a procedure is being defined the turtle does not respond to commands, so often the pupils worked with the turtle until they were clear about what commands are needed. However, generally, as pupils became more confident, they worked less in direct-drive preferring to define procedures straight off). Lisa and Everlyn work in direct-drive both writing the commands in their books as they go along (although they do name the super-procedure - TO UGLY - in their books). This method does have its problems: mistakes are made on the screen, but often written down; mistakes are corrected on the screen and also written down. The result can be a very messy and long procedure. As an example, FD 100 might be written down and typed in, but found to be too long; in direct-drive the following commands make it shorter: PE (pen erase - gives the turtle a rubber) BK 30 PD; these are also written down, but in fact all that needs to be noted is FD 70.

After working on the super-procedure for the face in direct-drive the following is noted:-

```
                              First         Second
                              edit          edit
TO UGLY
BCIRCL
PU
RT 90
FD 300
LT 90
   <------------------- PD
NOSE
PU
LT 45
FD 50 <---------------- FD 100
RT 45
PD <------------------- deleted
EYE <------------------ SCIRCL <-------deleted
BK 50
LT 90
FD 100
RT 90
PD
SCIRCL
PU
RT 90
FD 300
LT 90
   <------------------- PD
       <--------------- SCIRCL
PU
RT 180
FD 200
RT 90
FD 200 <--------------- FD 150 <------- FD 60
       <--------------- RT 180
PD
MOUTH
END
```

Under their own initiative they check through the procedure again, in direct-drive, and make the changes as indicated in the second and third columns above. They then type in the corrected procedure, calling it UGLY. However, UGLY is still not completely bug-free: it draws:-



They find it difficult to pin-point the error so I assist them, as time is running out. (Also, I know from past experience that it is easy for them to run into problems with long procedures as they have the tendency to delete too much too quickly). The bug is with the last RT 180, before MOUTH (put in on the first edit); it is edited to RT 90. This effectively de-bugs the procedure. Lisa and Everlyn are very pleased with the results. Lisa writes down the de-bugged procedure in her book as the session ends.

One of the most important things about this session was the girls use of subprocedures; imagine how long the procedure would have been had not the eyes, mouth, nose and head been defined first. Additionally, such a long procedure would have been particularly difficult to de-bug. Even in short procedures it could be difficult to locate bugs and relate commands to the drawing; subprocedures are so useful because each bit can be checked for bugs independently. And it is easier to locate errors, for it can be seen that, for instance, the eyes are right, so the bug must be <u>after</u> that subprocedure.

Lisa and Everlyn seemed generally confident (although they often thought tasks would be difficult), and enjoyed working on this more so than on smaller tasks. The face project had more of an end product. Although the Session worksheets were particularly useful in the early stages, as the pupils became more proficient, by and large, they preferred to spend more time working on larger projects, either made up themselves, or suggested on the sheets. But also, with this particular FACE project, the work was more enjoyable for Lisa and Everlyn because they had a clear idea of how they were going to tackle the problem before they started, and, probably partly as a result of this, they ran into fewer problems, and so became less frustrated or bored with the task.

There were other aspects of the Logo work which Lisa and Everlyn preferred.

7.4.1.3 **Lisa And Everlyn: Logo Likes And Dislikes.**

From general observation, unsurprisingly, the girls liked to work at the computer, typing in commands, in preference to the work away from the computer: there were often arguments about whose turn it was to key in the commands. Apart from this, I questioned Lisa and Everlyn on what they thought of Logo [T8A&B:CRp249-250]:-

ADB: Let's suppose that somebody younger in the school was moving up to Standard 3 or Standard 4 and was going to do some Logo and they didn't know anything about it at all, what would you tell them? What would you have to say about it?

L: Umm... It's good!

E: It's a triangle called the turtle.

L: There are a lot of commands for it.

E: Yeah... Umm... (....)

ADB: Say if I was new to it and I asked you what's the best thing about it, what I'd probably like the most about it?

E: The way it draws the right shape... just by pressing a button!

L: How it works. How to find out.

As Everlyn says, one of the best things about Logo is that (often after a lot of hard work), the desired shape can appear on the screen at the press of a button. Lisa liked the chance to investigate. The girls are also quite clear about what they are not so keen on:-

ADB: What about then if I asked you if there was anything I wouldn't like about it. What's the worst thing about it?

E: Working out the thing... When you've done all the drawing...

L: turnings...

E: and the turnings.

L: You get it all wrong and have to do it all again.

E: And the editing.

ADB: Editing? What's editing though, if I didn't know anything about it?

E: Umm...

L: Go back to where you... you...

E: Right, when you've wrote all your commands and you've tried it on the screen and it doesn't look right, you have to, well, you have to call it something first, then you've wrote all your commands, and it doesn't look right, so you edit what it's called, and then all the commands you've done is down so you look over the commands and check whether they're right or wrong.

L: Look for bugs. [T8A&B:CRp250]

For Lisa and Everlyn, editing out bugs was one of the least attractive things about Logo. But not all pupils were like these two. Before going further and considering the value of Logo in the primary school classroom, some of the other pupil-pair's work will be outlined, so providing further information and comparison.

7.4.2 Logo Pair Two: George and Norman.

7.4.2.1 George And Norman: Pupil Profiles.

In comparison with Lisa and Everlyn, George and Norman were a quiet pair who took their work seriously. George is quite an earnest boy, though not lacking in humour. He was a well respected member of the class and one of the few first language Welsh speakers.

Norman is a friendly boy who could happily balance work and play. As a pair, they worked well together. Both were good workers, and George was especially industrious and conscientious. They showed enthusiasm for the Logo work, applying a particularly high level of concentration. They persevered with their programs until they were satisfied with the result. And their standards were high. They were perfectionists - particularly George who would insist on making small changes which could barely be noticed on the screen, for example, changing BK 205 to BK 207 (Lf67). These boys took their work seriously. After expounding considerable effort on a program they would nervously peep at the screen through their fingers being afraid the program would not draw what they intended it to. George was frequently pessimistic saying, "I hope it works, but I doubt it will" (Lf56). If it did not work they often laughed at the result and then edited and re-edited the program until it was right.

I became increasingly impressed with George's enthusiasm, creativity and ability. It is interesting to report a chance conversation with his Mum. It was at the beginning of the school year and George had commented to her that he was pleased to have computers again. He had added that the work he had done that day had been a "cinch" (Lf8). However, she was surprised at his reaction thinking that he did not like computing. I was the more surprised at her belief! George seemed one of the most enthusiastic in the class. Maybe unsuccessful computer use at home could account for his Mum's opinion, for apparently George had a home computer, but had only ever succeeded in running two programs. He enjoyed his Logo work. Also, he was not a dominant boy, and this coupled with Norman's ability made for a fruitful partnership.

A word uttered by the class teacher seemed to sum up the pair accurately: they were "reliable" (Lf148). The class teacher had full confidence in their ability to get on well at secondary school. George and Norman's "star rating" was high (nine and eight stars respectively, by the second term). Their teacher thought of them both as "good and hard workers". She was pleased with them. Her opinion was clear on inspection of their exercise books: both their maths work was "excellent" and "very neat" too. From their maths books it seemed that George and Norman were equally matched in ability, and that this ability was great. Also maths was a favourite subject for both boys. (Surprisingly George commented that he did not really like any other subjects, although scripture and nature were "okay". Perhaps his ability led to boredom in some subjects). From the results of the graded arithematic test (Vernon and Miller, 1976), both were assessed as having a maths age in excess of 12 years and 3 months. George and Norman had scores of 53 and 44 respectively. It was surprising that their scores were not closer. On the basis of the test it was anticipated that Norman's class position would have been higher.

As for other areas of the curriculum, from their English books it seemed that their work was of an equally high standard; neat, grammatically correct and showing signs of added improvement. Further exercise books showed George's hard and conscientious work and general excellence. Comments in Norman's books proclaimed his "good, neat work".

7.4.2.2 George and Norman: Example of Logo Work.

The following illustration of George and Norman's work will provide a comparison with Lisa and Everlyn as well as give some grounding for the assessment of the value of Logo in the primary classroom.

The illustration chosen is of the boys' extended work on their own underwater design (Lf94-134; TAPE No.5:Side A [T5A] Case Record p200-236]. In order that their work can be fairly compared with Lisa and Everlyn's, it should be noted that the boys' work began in the late February, a number of weeks after the example of the girls' work. In the previous sessions, George and Norman had worked on writing procedures with variables (as suggested on the Session 14 sheets). Their work was impressive and George's enthusiasm, creativity and ability was noted. In that Logo session, they had looked ahead to the rest of the activities on Sesion 14; the last one proposes a "turtle project", suggesting that the pupils "design some shapes of your own using a variable in them". Upon reading this had George proclaimed "Oh smart!" (Lf69), but there was insufficient time to begin the project on that occasion.

A week passes before George and Norman return to the computer. This Logo session begins with ten minutes before lunch and continues for an hour in the afternoon. Directed by the activities on Session 14 they had worked on further shapes with variables. This time they still do not get as far as the "turtle project"; their attention had not been fully on their work - they had been distracted by the gradual depletion in the class numbers; pupils had been leaving for home, and warmth, because the school heating system had collapsed.

It is a further two weeks (half-term accounting for one) before George and Norman actually begin the "turtle project" to which they had looked forward. At the start of this one hour, ten minute session they experiment further with their procedure for drawing different sized pentagons which they had worked on in the previous session. They also load some of their other procedures from disk and introduce variables into them (Lf93/4). But they quickly tire of this and George announces:-

"Let's draw something and try and work it out" (Lf94).

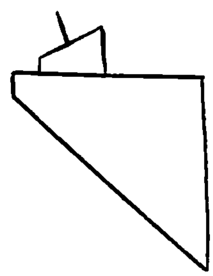
In other words, he sets a challenge. The intention is to draw a design on paper and work out the commands for drawing it on the screen. I find them some squared paper. George asks his partner, "what shall we do?" (Lf94). They contemplate several ideas - a map, a ship, a tumbled down house, a submarine... This latter they consider further - which way could it point across the paper? Perhaps it could come out of the paper towards them... This interests them and they settle on this idea. They ask if they can have a blue background to represent the sea. This seems like a good idea so the screen colour is changed to blue (SETBG 4), and the pen colour to yellow (SETPC 2) as they want a yellow submarine.

So far, so good; George and Norman have worked together and settled on an idea. But then, for no apparent reason, Norman starts working in direct-drive, drawing not a submarine but a ship! George, on the other hand, starts writing down the commands for drawing his sketch of the submarine. Initially I do not notice that they have stopped working together but I soon realize they have when George calls me over to ask about an angle. I question them both about what they are doing; Norman says he is drawing a ship as it will be easier. I do not comment. A few minutes pass: Norman continues drawing his ship in direct-drive; George persists in writing commands for his sub. George calls me over again to query something. I talk with them both. As a result, they begin to work together on the submarine which George has sketched on squared paper, for, as he points out, there is little point in Norman continuing with his ship as he had not written anything down and did not have a sketch of it (Lf95).

By the end of their Logo session, after spending quite some time editing the angles and the lengths, they have a procedure for the submarine. In this they showed considerable persistence as the angles and the lengths are not regular. The resultant procedure is the following:-

```
TO SUB
HT
SETBG 4
SETPC 2          (later changed to 10)
BK 300
LT 45
FD 400
RT 45
FD 25
RT 92
FD 290
BK 150
LT 95
FD 75
LT 110
FD 100
LT 70
FD 25
BK 25
RT 70
BK 50
RT 90
FD 50
END
```

It draws:-



(Lf95)

This is quite a long, unweildly procedure but it draws what is required. It may also be noted that the procedure is not state-transparent, i.e. it does not end where it began; additionally, the boys did not note where the turtle did end and this could lead to problems in the future. However, for some groups this might be a satisfactory end product for the "turtle project" (despite the absence of variables. This does not matter since the Session sheets were used for ideas and sometimes loosely followed). For George and Norman, although they are pleased with the result, they are full of ideas and want to add fish, rocks, ice-burgs and seaweed. George says:-

> "We can write separate procedures for each of them and call the whole thing 'undersea' or something" (Lf96).

They are both very keen to do this right away, but only a few minutes of the session remain, so I suggest that they save the SUB and think about what objects to add during the week.

At the next session (lasting an hour), George and Norman decide to draw their submarine coming through an ice-burg. They load SUB and draw it on the screen. Working in direct-drive, in Mode 2 (to accomodate the colours), Norman types the following commands which George writes down:- ST PU FD 100 BK 50 LT 70 FD 50 RT 90 and SEMI, which they load from their disk (Lf104). They had hoped to use SEMI as part of the ice-burg, but it is much too small so they clear the screen and start again. As before, Norman types in the commands which George calls out and writes down. The following is tried:- SUB ST PU FD 50 LT 70 FD 50 RT 90 LT 90 FD 100 (the last four are equivalent to FD 150), then RT 120 (they decide on a triangular rather than semi-circular "roof" for the ice-burg), then PD FD 300 (too long so) PE BK 300 PD RT 40 (the commands so far only move the turtle from the end of SUB to the start of the ice-burg; they could have isolated these move commands and put them in a separate procedure, but instead the boys continue straight on with) FD 300 RT 90 FD 800 (too far, so) PE BK 800 PD FD 550. At this point George suggests they draw the ice-burg on squared paper first (Lf105):-

G: Let's draw what we're going to do. Let's draw it on paper first. (...)

N: George, I think it would be better like this.

G: Let's do it like this, it will be easier.

N: You're just lazy George!

This is unusual, but even George can opt for the easy route sometimes! They have difficulties agreeing on the outline of the ice-burg. The following is typed in direct-drive, continuing on from where they left off:-
LT 120 FD 100 BK 100 RT 120 BK 550 LT 90. These last four commands retrace some of the turtle's steps. They do not want this so George crosses out these and instead writes, after the FD 550:-
LT 120 FD 550 RT 90 FD 100. They continue with:-
LT 90 FD 50 PU LT 90 FD 300 LT 45 FD 400 LT 90 FD 35
RT 90 FD 300 LT 90 FD 71 PD FD 500 RT 120 FD 200 RT 90
FD 100 LT 90 FD 125.

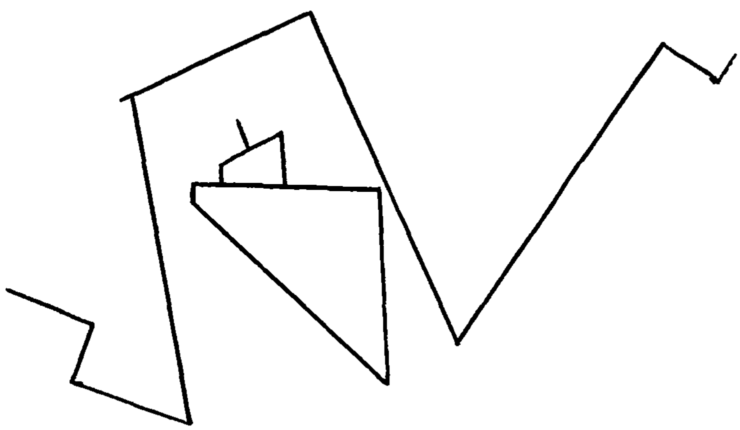
This gives the outline for the ice-burg. I ask them what they are going to do next. George says: "write a procedure for the ice-burg" (Lf106). I ask them if they can tidy up the commands they have worked out in direct-drive before they write it as a procedure. George had already done this as he noted the commands down, but they do read through it again. They decide to call the procedure ICE. I suggest they might change the pen colour from yellow for the ice-burg. They think about this and want flashing light-blue and white, but that is not available so they settle for flashing black and white. They type in the procedure:-

```
TO ICE
PU
SETPC 15
FD 50
LT 70
FD 150
RT 160
PD
FD 300
RT 90
FD 550
LT 120
FD 550
RT 90
FD 100
LT 90
FD 50
```

```
PU ----------------------------------|
LT 90        These commands direct   |
FD 300       the turtle from the     |
LT 45        right-hand end of the   |
FD 400       outline of the ice-burg |
LT 90        to the middle starting  |
FD 35        point, above the SUB,   |
RT 90        in order that the ice-  |
FD 300       burg can be continued   |
LT 90        towards the left.       |
FD 71                                |
PD ----------------------------------|

FD 500
RT 120
FD 200
RT 90
FD 100
LT 90
FD 125
END
```

SUB and ICE together draw:-



They put SUB and ICE together on the screen and it works. They decide to change the yellow pen colour of the SUB to flashing purple and green. This they do by SETPC 13. As the ICE procedure stands, it is very long and would have been better if it had been broken up into parts, but the actual drawing did not lend itself to easy separation. However, the two moves contained in the procedure could have been written as separate procedures.

Although the work had required considerable concentration, George and Norman are keen to continue. They want to add fish to the scene. I suggest they draw a fish on squared paper first. A circular fish with a square tail is drawn, but it does not look much like a fish. Prompted by me, they consider a fish shape made by two crossing arcs, the cross-over forming the tail. George spots that something like a semi-circle could be used, but less of an arc. They experiment with the following:-

```
TO FISH
SETPC 14
REPEAT 80 [FD 1 RT 2]
END
```

They employ their knowledge of semi-circles to write this procedure which draws a curve, short of a full semi-circle. In this they have used their knowledge that the number of repeats multiplied by the turning must equal 180 for a semi-circle. However, the resulting shape is too big. Surprisingly, rather than making the shape smaller, they edit in BK 55 and LT 30 before the repeat command. The outcome is nothing like a fish. Drawing the curved-shaped fish causes problems; they opt out of solving the problem by suggesting instead that straight lines could be used, to represent eels! I ask them if there are eels at the North Pole (the setting of the scene). The session ends with them agreeing to think about fish during the week.

Before they leave, they put SUB and ICE in a super-procedure called POLE and save it.

The next session lasts one hour, 15 minutes and in it George and Norman add further subprocedures. They had not forgotten where they had left off last week, and quickly write the following procedure for fish:-

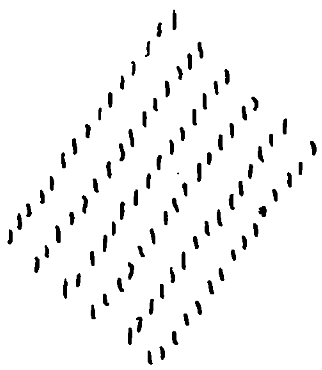
```
TO FISH
SETPC 14
REPEAT 15 [FD 25  PU  RT 90  FD 15  PD  LT 90]
END
```

This procedure draws a number of "fish"; each fish is simply a straight line, but by repeating it, at an angle, with a small gap between each "fish", the overall effect is better than might be expected. Indeed, at certain angles across the screen the FISH procedure draws a line of <u>squiggly</u> fish, because of the limitations of the screen. When this is done the result is much more realistic.

George and Norman discuss making a shoal to add to their picture. They talk about where the shoal should go and write this procedure:-

```
TO SHOAL
RT 15
PU
BK 600
PD
FISH
REPEAT 3 [RT 15  PU  BK 600  PD  FISH]
END
```

(The contents of this procedure could have been more simply written as REPEAT 4 [RT 15 PU BK 600 PD FISH]). However, this procedure does not do what the boys intended. Their idea of a shoal is four or five lines of FISH going off at an angle, like so:-



What their SHOAL procedure does is scatter four lines of FISH about the screen, rather than together. This is because George and Norman have repeated the commands to move the turtle from the end of ICE to the position of the SHOAL within the SHOAL procedure. Therefore, before each fish, the turtle does RT 15 PU BK 600 and PD. This is not what the boys intended to happen. This mistake is further evidence of the value of writing separate procedures for positioning the turtle between subprocedures. Including positioning commands within procedures was a frequent cause of problems.

At this point, George and Norman do not clearly see the error in their SHOAL procedure. They edit SHOAL to:-

```
TO SHOAL
FISH
RT 40
PU
BK 600
PD
FISH
REPEAT 3 [RT 40  PU  BK 600  PD  FISH]
END
```

This obviously does not improve matters. The boys have not spotted the cause of the problem. They become confused. They seem to think the problem lies with the turning so they edit again this time simply changing the RT 40s to RT 30s. They try SHOAL and the result leads to further confusion. At this stage I intervene and work with George and Norman in direct-drive. It soon becomes apparent that the move commands should not be repeated. Having resolved this difficulty, the next problem is working out the commands for moving the turtle from the end of the first FISH in the shoal to the start of the second FISH. The value of noting the position of the turtle at the end of the procedure is realized. Working in direct-drive, it is found that the following commands move the turtle to a desired position ready for drawing the next FISH:-

```
PU   BK 30   RT 25   BK 420   PD   LT 25
```

George and Norman are left to edit SHOAL to:-

```
TO SHOAL
FISH
REPEAT 5 [PU  BK 30  RT 25  BK 420  PD  LT 25  FISH]
END
```

The resulting SHOAL satisfies the boys.

Two observations might be made at this stage. The first is the importance of teacher intervention at times of confusion. The difficulty, once again, is knowing the point to intervene. Indeed, there can be no saying for sure that the point of intervention in this instance was right; maybe George and Norman would have spotted the reason for the problem themselves, if they had been left alone; but maybe frustration would have set in and they might have abandoned the shoal. As it turned out, by intervening, the boys attention was focused on the value of noting the end position of the turtle. Perhaps also they were able to grasp the value of separating between-procedure moves. However, this comment leads to a second observation; in editing SHOAL the boys did not employ this tactic, for the procedure could have been more neatly composed if the commands PU   BK 30   RT 25   BK 420   PD   LT 25 had been written as a separate procedure, called MOVE for instance, so that SHOAL became:-

```
TO SHOAL
REPEAT 5 [FISH MOVE]
FISH
END
```

Generally, it is a sound programming tactic to isolate move commands but one that is difficult to communicate to children. However, it was encouraging to see George and Norman utilize this technique later.

At this point, the boys had only displayed SHOAL on the screen alone; they need to position it on the underwater scene. Prior to working in direct-drive they had already worked out the necessary commands, namely a right turning and PU, BK 400 and PD. They decide to dispense with the turning and simply add PU BK 400 to the end of ICE. Again, it would have been better to have written this move as a separate procedure. It is also a little surprising that they decided to include this move in ICE, rather than at the start of SHOAL.

Having done this, George and Norman add SHOAL to the super-procedure, POLE, and display the result on the screen. I look at the screen; a submarine, an ice-burg and a shoal of fish. I study the scene but cannot quite relate to what is effectively a three-dimensional picture, in two dimensions. The following conversation ensues:-

ADB: Is that right?

G: Yeah.

ADB: Do you want them in that position?

G: Yeah, they're going up to the surface... Yeah, that's right.

N: Yeah, but on that picture you've drawn, they go through there.

G: Yeah, but I want them at the surface.

N: Right.

ADB: I... Let me work this out...

G: Fish don't go in straight lines. (He seems to anticipate criticism).

ADB: If those fish are at the surface of the water, right?

G: Noooooo!

ADB: No, they're not?

G: No, they're going towards the surface.

ADB: They're going towards...

G: They're going up.

ADB: Right, they're going towards the surface.

G: They're going up there. There's the surface.

ADB: There's the water surface. And the submarine is coming towards us underneath the water...

G: Yeah, Yeah...

ADB: What's this, is the submarine coming through the ice?

G: That's... Yes.

ADB: The ice is under the water?

G: Yeah, yeah.

ADB: Right. Where's the ice? Is the ice here?

G: Yeah, the black and white one's all ice.

N: No, that's all ice.

G: The black and white.

ADB: All this is ice?

N: Yeah.

G & N: The water, that's ice, that's water.

G: That's ice in water.

ADB: Really we could do with it all to be white, yeah. Oh, I see. Right.
[T5A:CRp218-219]

To me, the picture looked quite confused, but George and Norman clearly knew what they were doing! Perhaps this conversation suggests that it is easy for a teacher to impose an interpretation of what is going on; here, I could not understand the drawing and, not recognizing the value of the picture, might have dismissed it as a muddle. But, listening to the pupils' explanation made the picture clear.

Norman had already indicated that he was not completely satisfied with the positioning of SHOAL. George agrees to work with him to change it. After finishing ICE, the turtle's position for drawing SHOAL needs to change: George usefully suggests using the commands PU and HOME:-

> "Oh, I know! PU HOME then start the FISH going up!" [T5A:CRp219]

These commands will return the turtle to the centre of the screen, facing up. They try the following for the new positioning of SHOAL:-

SUB ICE PU HOME ST LT 80 PD SHOAL

Norman is still not satisfied with this result:-

> "But they're missing the ice - that's where I want it. They're going from the ice. They are going down there now. Put it further down." [T5A:CRp220]

The boys work together on re-positioning the SHOAL. Their conversation reveals the extent of their co-operation:-

N: Will it do if they're down there?

G: CS. Write it down.

N: POLE.

G: We'll do it now, after POLE. Put POLE. No, don't put POLE. Just put PU.

N: Yeah.

G: POLE.

N: BK. It's there now.

G: That's 400.

N: Turn it a bit. Left.

G: Left what? Left 80 yeah?

N: LT 45.

G: Okay.

N: And that'll bring it to there. Then back a bit. How much do you think that will be?

G: 400.

N: That was 200 there. Put that 400.

G: This ain't going to work!

N: So the turtle's there now, facing that way.

G: Now SHOAL. BK 400.

N: No, then, then turn it a bit left.

G: Norman! We've done it... Left 45!

ADB: Last time you had left 80.

N: But we turned it just to get it down there so the turtle's somewhere there now. And then we're going to go up. So 45... LT 45.

G: 35? 45?

N: LT 35.

G: 35 PD PD. SHOAL.... Yeaeh!! Is that alright Norman? Don't say it isn't cause they're passing... the ice has gone. [T5A:CRp220-1]

The boys relationship is good; they work well together and are absorbed with their work. Now that they have satisfactorily positioned the SHOAL, I ask them what they intend to do next:-

G: Edit POLE.

N: Join them together.

G: No, edit SHOAL and put that in.

N: Yeah, edit SHOAL and put that in. And then we'll add SHOAL to POLE.

G: Yeah. [T5A:CRp222]

They are clear about what they are going to do and demonstrate an ability to manipulate procedures. They are able to handle subprocedures on different levels, i.e. FISH is a subprocedure of SHOAL which is a subprocedure of POLE. They first edit SHOAL and change it to:-

```
TO SHOAL
REPEAT 5 [PU  BK 30  RT 25  BK 420  PD  LT 25  FISH]
PU
HOME
LT 45
BK 400
LT 35
PD
END
```

This is not right. Norman immediately spots the problem: the last six commands should go <u>before</u> the REPEAT, not after it, as these are the positioning commands for the shoal. George decides that the best way to remedy this is to edit SHOAL, take out the move commands, edit POLE and put them in after ICE. This line of thinking results in:-

```
TO POLE
SUB          HOME         LT 45
ICE          LT45         PD
PU           BK 400       SHOAL
                          END
```

The problem could have been more neatly handled by writing these move commands as a separate procedure, but the boys do not yet use this tactic, and what they have done does solve the problem.

Having done this, I expect that they will now want to move on to something else. George had already spied what others were doing; some were drawing a tower, as suggested on a Session sheet: he looks forward to this task and plans to extent it:-

G: When we get the time, we can draw a whole castle. When we do the tower yeah, we can do the whole castle yeah. (To me) Urmmm, after we've done the tower like that, can we draw a castle? [T5A:CRp222]

I tell him that of course he can, but should finish what he's working on first. Norman comments: "George's suggestions! He never stops!" [T5A:CRp222]. Norman's remark turns out to be quite ironic, for, when asked if there is anything more they would like to add to the underwater design, it is Norman who is keen to continue: he suggests:-

N: Seaweed. Seaweed.

G: No... Shall we go on to something else?

N: No, do seaweed, for the last ten minutes.

G: I want to draw a torpedo!

N: Do seaweed.

G: Okay, just do little curves of green. [T5A:CRp224]

These boys really do work well together. Deciding to work on what Norman wants to do for the last ten minutes is a compromise; neither boy tried to overpower the other. It may also be noted that Norman's enthusiasm for adding something further sparked off George's imagination; he suggested a torpedo! A little later, George throws in further ideas (before the seaweed is finished):-

G: I've just got a good idea - draw a seal.

N: Urggh!

G: Draw a deep-sea diver! Draw us going for a swim underneath it!

N: Yeah, in the bottom. [T5A:CRp225-226]

The boys were constantly full of ideas and plans and really did seem to enjoy their Logo work.

Having decided to draw seaweed, the boys spend some time selecting colours. Norman wants a flashing green and purple pen colour, but George, fortuitously says: "let's have something not flashing!". They settle on

SETPC 2 which is green. They then discuss a shape for the seaweed:-

G: Do a semi-circle.

N: Just do a line. [Pause]
Now what? I know what to do. Just do a line like that. Just do the turtle there now. Then turn it, draw it up there and then you turn it and draw it up there.

G: That's a 'V' shape. Why don't you just do a curve, like that?

N: Just do it like that - one up the middle, one there and one there.
[T5A:CRp225]

George accepts Norman's design. They work quickly: Norman works out the commands in his head (not using direct-drive); George writes them down, but also follows what is being done. The result is:-

```
TO WEED
PU
BK 300
PD
FD 100
BK 100
LT 45
FD 100
BK 100
RT 90
FD 100
BK 100
END
```

This draws:-

The shape is what was planned, except too big. The first three commands position the turtle. George and Norman discuss the size, colour and positioning, and as a result, edit WEED to:-

```
TO WEED
SETPC 16            LT 45
PU                  FD 100
HOME                BK 100
BK 380              RT 90
PD                  FD 100
FD 100              BK 100
BK 100              END
```

They decide against changing the size of the seaweed. Finally, at the end of the session, the boys edit POLE and add their WEED subprocedure.

Without suggestion from me, at the start of the next session, the following week, George and Norman carry on from where they left off, and add a line of WEED to the bottom of the design (Lf128). For this, they work out the commands required to move the turtle from the end of WEED to the start of the next WEED. This time, uncharacteristically, they write these commands as a separate procedure which they call MOV:-

```
TO MOV
PU
RT 45
FD 100
PD
LT 90
END
```

They encounter some problems when they experiment with MOV and WEED; the WEED procedure itself contains some commands that move the turtle from the end of SHOAL to the starting position of WEED. They quickly solve this problem by editing out the move commands in WEED and writing these as a self-contained procedure they call M. This tidies up their program no end. Now when they repeat WEED and MOV they get the desired effect. This in turn is written as a procedure called SEABED:-

```
TO SEABED
REPEAT 13 [WEED MOV]
END
```

SEABED and M are added to the super-procedure giving:-

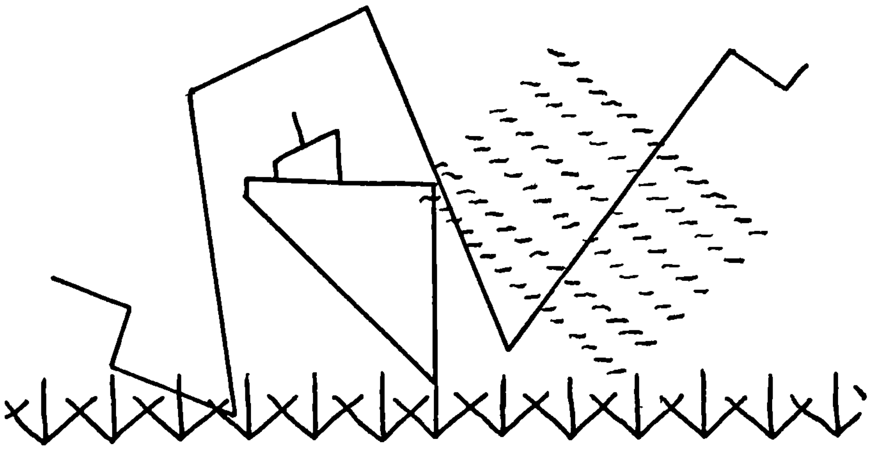
```
TO POLE
SUB          LT 35
ICE          PD
PU           SHOAL
HOME         M
LT 45        SEABED
BK 400       END
```

Very unfortunately, when George and Norman try out the command

POLE, the message "OUT OF SPACE" is given, meaning there is insufficient memory in the computer to handle all the commands. George suggests that making POLE shorter, by taking out the positioning commands between ICE and SHOAL, and writing these as a separate procedure, might solve the problem. I do not think it will, but do not discourage them because this is a good programming tactic anyway. They try this, calling the procedure MO and edit POLE so that it becomes:-

```
TO POLE
SUB
ICE
MO
SHOAL
M
SEABED
END
```

This usefully tidies up the procedure, but the OUT OF SPACE message is still given. Trying to overcome this problem takes up the rest of the session. The lack of memory space is mainly caused by working in MODE 2 which allows more colours, but in so doing, uses up more memory space. Additionally, for some reason, when one procedure is loaded off disk, it calls up many other procedures, some of which are not required in the design, and all these procedures take up a great deal of memory space. The problem is finally overcome by saving all the POLE subprocedures on a different disk, then when POLE is loaded no unwanted procedures are loaded along with it. A listing of the procedures can be found in the notes section at the end of this chapter{2}. It draws:-



The work on this underwater design has shown the boys' perseverance, resourcefulness and self-motivation. They made good use of subprocedures (although they might have made use of separate move procedures sooner). Although the procedures themselves were quite basic, the boys revealed that they could operate on many levels; they understood that, for example, FISH was a subprocedure of SHOAL which, in turn, was a subprocedure of POLE.

George and Norman were disappointed and frustrated by the lack of memory problems, but eventually pleased with the result. At the end of the session, they ask if it can be printed out, which I do for them during the week. I ask what they would like to do next week; they both agree to start on something fresh, namely the tower design and the plans for the castle.

7.4.2.3 **George And Norman: Logo Likes And Dislikes.**

The project work was an aspect of Logo that George and Norman particularly liked. When I asked them what they liked most about Logo, they responded:-

G: Making up your own...

N: Making up your own...

G: Making up your own pictures.

N: Making up your own pictures.

ADB: What's nice about that then?

N: You can invent all sorts

G: Yeah, you can draw them on a piece of paper and try and work out the turnings. [T8A:CRp246]

George and Norman were a pair who particularly revelled in the freedom to direct their own activities. They were glad of the opportunity to be inventive and creative. The suggestion that work should be on own designs was usually met with cries of "Oh smart!" (Lf64 Lf65, Lf80) from these two and other pupils.

When asked if there was anything that they did not like about Logo, the following response was elicited:-

ADB: ... What's something you don't like about it? [Pause]

G: I don't know.

ADB: Nothing? It's that good is it? Nothing that you might get a bit frustrated or cross about?

G: When we get arguments about what we are going to do.

N: About what we're going to draw...

ADB: How do you resolve these arguments then?

G: He does one procedure and I do the other! [T8A:CRp246]

Unlike Lisa and Everlyn, George and Norman did not seem to mind editing procedures and de-bugging. This is perhaps slightly surprising for even adult programmers can experience feelings of irritation and frustration about bugs in programs. George and Norman seemed to view it as all part and parcel of what they were doing, and simply got on with it! This indicates one point of comparison between the two pairs of children studied; there are other contrasts.

7.4.3 Pupil Pair Comparisons.

It became clear, that as a Logo pair, George and Norman showed greater powers of concentration than Lisa and Everlyn; generally they were more enthusiastic and absorbed with their work. Lisa and Everlyn tended to give up more quickly when confronted with problems; as they said, they did not like it when things went wrong and procedures needed editing. As the illustrations have shown, the girls were less keen to make improvements and were discouraged by designs that looked too difficult. On the other hand, George and Norman looked for something challenging. When encouraged to work on their own designs, they tended to quickly set themselves a challenge, whereas Lisa and Everlyn tended to show less enthusiasm, and would choose something "easy" to do, that is if they could think of anything at all to do. But this was not always the case, and indeed, there was one notable exception: one of their last projects was an "olympic" design; they chose this from an array of possibilities, and when asked about this choice, Everlyn responded:-

> "You know you're going for something better instead of just easy" [T8A&B:CRp253]

This turned out to be some of their very best work, and interestingly, when asked why it had worked so well, Lisa replied that it:-

> "helps a lot to work it all out first." (Lf154)

Perhaps if there had been time for more Logo work, Lisa and Everlyn might have been seen to increasingly choose more challenging work and engage in more preplanning.

George and Norman never showed any problems over ideas for designs to work on; they were very resourceful and creative in this direction. Lisa and Everlyn, on occasions, simply could not think of anything to do. From such observations, it seems that some children are more resourceful than others (or on more occasions). These benefit more from open learning situations; others seem to require direction.

There are further points of contrast, in their programming. George and Norman's approach tended to be more systematic and reflective than the girls, although both pairs showed considerable skill in breaking down problems into parts, and both were able to employ subprocedures successfully. However, there was room for improvement in all the pupils' programming: more often than not, as has been seen, moves between subprocedures were included within subprocedures. Also, most procedures were not state-transparent when it was convenient for them to be so. And even when this was inappropriate, the pupils tended not to note the turtle's end position, upon completing a particular procedure. Both these limitations in programming tactics lead to numerous problems as the illustrations have shown. However, at least in George and Norman's work, such tactics were beginning to be employed.

The next section will briefly consider some of the difficulties that children have been seen to encounter in Logo programming.

7.4.4 Logo, Children And Difficulties.

Some other difficulties that have shown themselves in the study. They include:-

(1)**Utilizing Subprocedures:** it was noticed that children take a long time to see the benefit of breaking the problem down into smaller parts and writing subprocedures. The case study illustrations have shown both pairs using subprocedures, but this is after regular Logo sessions spanning more than four terms. It was also noticed that sometimes sub-procedures were written, but <u>not</u> used in the programming! (Lf38 for instance).

(2)**De-bugging:** pupils found it difficult to locate bugs in long procecures. Using subprocedures made de-bugging easier.

(3)**Turtle Positioning:** as has already been noted, the lack of importance children seemed to attach to noting the position of the turtle at the end of a set of commands, lead to many bugs in programming (Lf164, for example). Not noting the end position lead to problems with positioning the turtle for the next procedure (Lf139/140). To alleviate this problem, pupils could be encouraged to write state-transparent procedures where appropriate, and also separate move procedures, as has been discussed.

(4)**Understanding New Concepts:** generally it was found that children need much more time than might be anticipated to explore and understand new concepts (for instance, editing, subprocedures, recursion, variables). It was also found to be dangerous to assume that a child understands variables, for example, simply because a procedure can be written containing them: lack of understanding was clear in responses to the message "NOT ENOUGH INPUTS TO..."; they would think that the procedure needed editing, when all that is needed is a value for the variable (Lf60/61; Lf109). As further evidence of the large amount of time required to explore new ideas, it was seen that pupils had difficulties exploring the general formula:-

REPEAT number of times [FD so many steps RT 360/number of times]

They could use it in the sense of filling in the appropriate numbers, but they were unable to explain what it meant (Lf18, Lf21). This leads to a further distinct difficulty.

(5)**Explaining In Words (verbal or written)**: when asked something like "how are you going to draw your design on the screen?", children tended to answer in terms of turtle commands. Although in practice they might be seen to break the problem down into parts, write and test programs for each, and put the whole thing together, they found it difficult to verbalize their method.

(6)**"Playing Turtle" To A Set Of Commands**: it is perhaps unexpected that pupils had difficulties doing this. As an exercise, the class was given a set of commands and asked to draw on paper the trail the turtle would make; not one pupil could do it successfully. And this was towards the end of the fourth year Junior. The following is the list of commands they were asked to carry out (Lf101):-

```
TO SHAPE
FD 50
BOX                          TO BOX
FD 75                        REPEAT 4[FD 60   RT 90]
RT 90                        END
BOX
END
```

However, in the class's favour, it will be seen that this is a recursive procedure: rather than "playing turtle" being a difficulty in itself, it might be that just recursion is the problem. But many of the above mentioned difficulties overlap one another. And also, this is not an exhaustive list, although those noted here are some of the more common and general ones. Of course, not all groups of children using Logo will encounter such difficulties, and it is quite possible that some of them are the result of the approach taken to the teaching of Logo: if greater emphasis had been put on turtle positioning, for example, then probably children would not have had difficulties with it. However, one of the most important points to emphasize is the observation that children take a long time to grasp many of the concepts in Logo. This is not to under-estimate the pupils' ability, rather, to act as a warning to those who think children can be "taught" Logo in a few weeks.

7.5 The Value Of Logo.

Before the examples of Logo work were outlined, some of the claims made for Logo (principally by Papert) were presented. It is now appropriate to reconsider these in the light of the study. In the interests of brevity, the learning gains from Logo will be considered under three headings.

(1)**Aspects Of Mathematics:** If Logo was to be "sold" to the more traditionally minded teacher, then its benefits in terms of aspects of mathematics would most probably be emphasized. For example, angle, estimation and even algebraic work. It is quite clear, from observation that the Logo work did help in the learning of some mathematics. As Lisa naively said in response to the question "What have you learnt from Logo?":-

"How to use the protractor" [T8A&B:CRp250]

The Headteacher at Longsight school saw the value of Logo partly in these terms, but he also recognized that Logo could extend the existing mathematics curriculum. He said of the Logo work:-

> "Children undergoing this project... did some mathematics that we wouldn't, under normal circumstances, have attempted with children of that age... for example, introducing the term 'variables'... But they took to it quite easily and quite readily and accepted it for what it was and understood it, and I think with the visual aspect of Logo, and seeing the results on the screen that this helped them in their learning process." (Li5/6)

The visual, or concrete nature of Logo, in the Headteacher's opinion assisted children in their understanding of problems. This aspect of Logo has been recognized as an advantage by other writers. However, Papert has made stronger claims for Logo; rather than simply helping children learn aspects of mathematics, he speaks of Logo supplying, or introducing children to, thinking tools. This is considered under the next heading.

(2)**Thinking Tools And Problem Solving Strategies:** Does Logo help children think mathematically, or employ the scientific method? Does it supply them with problem solving strategies, which are transferable to other learning situations? It is particularly difficult to present evidence in support of claims of this nature. What can be said, from this particular study, is that as George and Norman's and Lisa and Everlyn's Logo experience increased, so they employed "problem solving strategies" more and more. They were increasingly seen to break the problem down into parts and write procedures for each. And they were seen to use the "scientific method" in that they examined the problem, wrote a program for it; tested it; de-bugged it; tested it again and did more de-bugging if necessary. This study does then support the claim that Logo encourages problem solving skills, but whether these skills, as seen in the case study pupils, were transferred to other curriculum areas, was not examined. To do this is especially problematic as there are no easy and reliable ways to test for transfer of problem solving skills. The Head commented on what he saw; he stated that, although initially going into the unknown, on reflection, the children greatly benefited from the work:-

> "...it taught them to think logically... I think this... was of prime importance. Secondly... they were put into a problem solving situation... It also gave the less-able child a great deal of confidence." (Li5).

These benefits are of a general but important nature. The Headteacher believed that the Logo work was a valuable experience for the children and that the learning was worthwhile. What he says about the less-able child gaining in confidence, leads to the third area of learning gain that will be considered.

(3)**Qualities In Attitude To Work:** This too is a learning gain of a general nature, but again, on less important for that. Under this heading might be included such qualities as: self-confidence, motivation, co-operation, collaboration and negotiation.

Once again, it is difficult to assess the claim that the Logo environment encourages such qualities. What could certainly be said is that Logo in itself does not encourage these qualities. It has the potential, but it all depends on the way in which it is handled in the classroom. Children can work in the Logo environment in isolation and in such circumstances it would be difficult to see that Logo encouraged co-operation, collaboration or negotiation. However, it can be seen from the case study illustrations that gains of this nature may be made if pupils are well paired. A well suited pair can develop skills of discussion and argument. But likewise, a badly paired couple can mean a poor learning environment, with one dominating the other, for instance.

To summarize broadly, it seems that the gains to be made from using Logo in the classroom are heavily dependent on the way it is handled by the teachers in the schools. Yet again, we are reminded that nothing should be assumed about a school's approach to computer education without spending time in the school. Attention can now be returned to the important question raised earlier, namely, is it true to say that

Longsight school adopted a Conjectoral approach to computer education, or is there in any sense, a non-correspondence between the Logo philosophy and what that implies about computer education, and the attitudes of the teachers to microcomputers in primary education?

7.6 <u>Computer Education At Longsight.</u>

When the policy document was considered in an earlier section, it was anticipated that Logo and the conjectural paradigm might be suited to the school's interpretation of computer education. However, a certain amount of non-correspondence was revealed upon examination of teachers' words and actions. And now it is clear that Logo may be approached in a number of ways, not all of which are in tune with its underlying philosophy. At Longsight school, although Logo had been used extensively, it did not seem that a Conjectural approach to computer education had been explicitly adopted by the teachers. Nor does it seem likely that it will be adopted in the future. On asking the Headteacher if he would wholeheartedly recommend Logo to other primary schools, he said that he found having one person responsible for the work invaluable, to such an extent that he voiced reservations about encouraging other schools to take it on (Li7). However, he also said that he would like to develop the Logo work, but added:-

> "without taking part in this project, I don't think we would have gone very far with Logo." (Li18).

Not all teachers involved with Logo are of this opinion. Indeed, it is unlikely that schools would be in a position to have someone responsible for the Logo work. Hence, although Logo is apparently in tune with some of the stated policies of the school, the attitude that Logo is difficult for the class teacher to use on his/her own might prevent its future acceptance at Longsight. Additionally, this attitude implies something about the place of Logo on the curriculum: if the ideal is to have someone responsible for the Logo work then there is the likelihood that it will become divorced from the rest of the curriculum. This was the case in the fourth year Junior class. The school's use of Logo was very much linked to my research involvement. Indeed, upon returning to the school after the Easter break, it was found that the computer corner in the fourth year Junior classroom had become somewhat swamped by other equipment: the computers had not been used recently. An electrical problem partly explained this; the plugs had had to be temporarily removed, and had not been immediately replaced. The renewal of my visits quickly rectified this situation (Lf147). Increasingly I came away with the impression that little Logo work was taking place in my absence and that this had serious implications for the acceptance of Logo and its integration into the curriculum (Lf154). In fact, a visit to Longsight in Autumn 1986 (after the main fieldwork period) revealed that all the computers had been removed from the fourth year Junior class (Lf173). The University had reclaimed its equipment partly accounting for this, but the school's micro had also been removed. The Headteacher was working with small groups of children in a spare classroom. The devotion to Logo had diminished.

Having considered in detail the use of Logo at Longsight, it is apparent that there was some non-correspondence between the image of computer education implied by this application and the reality of the situation. The Headteacher was at the stage of thinking about various different routes that might be followed. He expressed some amount of uncertainty about the situation:-

> "There are so many fields, the mind boggles in which direction we'll go... perhaps I'm only scratching at the surface..." (Li18).

Frankly, the Headteacher was hesistant about the future of computer education in his school. This is not intended as criticism for there are are many problems to be surpassed before the micro is fully integrated, and welcomed into the curriculum. Sections in the final chapter (nine) look to the future of computer education in the three schools.

7.7 Summary And Conclusions.

In many ways, it is more difficult to assess the question of correspondence or discrepency between the interpretation of computer education implied by using Logo, and the reality of the situation at Longsight school. This difficulty largely arises because of my special involvement with the school and Logo. It may be spectulated that a very different image of computer education might have arisen had it not been for the school's involvement in the Logo project. And, as the Head intimated, (Li18), the future of computer education at the school, now that the University's involvement has ceased, is uncertain.

It should also be clear that it is dangerous simply to assume that because a school uses Logo, the underlying philosophy is also supported. Papert (1980) has made clear his thinking behind using Logo, but in practice, it can be used in ways at odds with the philosophy. It may even be the case that it is easier to distort Logo and use it to support a more traditional view of education, than to use it in the way intended. Logo work, for instance, could be very teacher-directed with no room for pupil exploration.

Although computer use at Longsight school was very different from that at Ben Mercy or Headland, it might be suggested that there are still points of similarity. Longsight had been exploring one particular avenue, and, having spent some time on this, the Head expressed the desire to try other things with the computer. Ben Mercy and Headland were also at the stage of exploration. Another point of similarity is that at Longsight school too, although more difficult to assess, there was a degree of non-correspondence between the image of computer education implied by using Logo and the reality of the situation. All this says something about microcomputers and educational processes. In theory, certain computer applications might be expected to improve the quality of the educational processes offered by schools. It might have been anticipated that Logo would have so improved processes at Longsight school. What the empirical research has shown is that judgements about improvements in the quality of educational processes are not at all easy to make, partly because of the presence of non-correspondence which seems to support, if anything, the contention that microcomputers are <u>not</u> being used in schools to improve educational processes. The case study schools were at an exploratory stage. Where teachers dabble with the computer without giving much thought to its educational value, it might be expected that it will not have a far reaching effect on the educational processes.

The final chapter pursues the message of non-correspondence gained from the case studies and looks to the future of computer education in the three schools, and more generally. Before this however, the next chapter focuses on children's responses to the micro, and the hypothesis that how schools use micros has a powerful effect on children's attitudes.

Chapter Seven: Notes.

{1}A Note On Commands.

Logo employs certain abbreviations which are used in the programs in the illustrations. The following is a list of the more common commands:-

FD	forward (followed by a number of turtle steps, giving length)
BK	backward (followed by a number of turtle steps, giving length)
RT	right turn (followed by a number of degrees)
LT	left turn (followed by a number of degrees)
PU	pen up (lifts the "pen" so no line is drawn)
PD	pen down (lowers the "pen" ready for drawing)
HOME	Returns the turtle, leaving a trail, to the centre, facing up.
TO	TO indicates the start of a procedure. It is followed by a title and definition.
END	END indicates the end of a procedure.
EDIT "	EDIT followed by "name of procedure puts Logo in edit mode ready for editing the procedure.

The children write procedures in their work. A brief explanation of this was provided earlier (page 184). The example used was a procedure for writing a square.

{2}A Listing Of The Logo Commands Used In George and Norman's Underwater Design.

```
TO POLE
SUB
ICE
MO
SHOAL
M
SEABED
END
```

```
TO SUB
HT
SETBG4
SETPC 10
BK 300
LT 45
FD 400
RT 45
FD 25
RT 92
FD 290
BK 150
LT 95
FD 75
LT 110
FD 100
LT 70
FD 25
BK 25
RT 70
BK 50
RT 90
FD 50
END
```

```
TO ICE
PU
SETPC 15
FD 50
LT 70
FD 150
RT 160
PD
FD 300
RT 90
FD 550
LT 120
FD 550
RT 90
FD 100
LT 90
FD 50
PU
LT 90
FD 300
LT 45
FD 400
LT 90
FD 35
RT 90
FD 300
LT 90
FD 71
PD
FD 500
RT 120
FD 200
RT 90
FD 100
LT 90
FD 125
PU
BK 400
END
```

```
TO MO
PU
HOME
LT 45
BK 400
LT 35
PD
END
```

```
TO M
SETPC16
PU
HOME
BK 380
PD
END
```

```
TO SHOAL
FISH
REPEAT 5 [PU  BK 30  RT 25  BK 420  PD  LT 25  FISH]
END
```

```
TO FISH
SETPC 14
REPEAT 15 [FD 25  PU  RT 90  FD 15  PD  LT 90]
END
```

```
TO SEABED
REPEAT 13 [WEED MOV]
END
```

```
TO WEED
FD 100
BK 100
LT 45
FD 100
BK 100
RT 90
FD 100
BK 100
END
```

```
TO MOV
PU
RT 45
FD 100
PD
LT 90
END
```

Chapter Eight: CHILDREN'S RESPONSES TO COMPUTERS.

8.1 Introduction.

Since the case study schools employed different (although difficult to pin down) interpretations of computer education, it is interesting to explore whether or not this affected the pupils' attitudes to the microcomputer. From time spent in the schools and from conversation with the children, certain attitudes were revealed. These impressions were followed up with an attitude questionnaire presented to the top two Junior classes. This work is reported in a later part of this chapter. To begin, information gained from the main fieldwork period is considered.

8.1.1 General Impressions: Enthusiastic Response.

Children's enthusiastic response to computers in the school was almost universal. Whatever the machine was used for, most pupils seemed eager and keen to work on it.

At Headland school, this enthusiastic response was clear. It was usual for pupils to ask to "have another go" and stay longer (Hf11, Hf16, Hf19, Hf24). Most groups of children that came to the computer were reluctant to leave and wanted "one last go". This response was made despite the bell ringing for break-time and despite pupils having labelled the program as "boring". Several explanations may be proferred; avoidance of wet weather, dull class work, or desire for more individual attention.

As the computer at Headland was usually set up in a central part of the Junior open-planned area, it attracted the attention of passing pupils. Children stopped to watch, displaying a keen interest in the computer activity (Hf42). This enthusiasm for computer work was further revealed when the members of the fourth year Junior class were asked who would be prepared to miss the weekly television program to work on the computer instead (Hf60). Virtually every class member raised a hand. However, one boy did comment that the television programme was "boring". The reaction to the computer was favourable but the reasons for this are questionable.

The pupils at Ben Mercy displayed equal enthusiasm towards the computer (Bf4, Bf9, Bf29...), and again, they were usually happy to continue working through Break.

The Logo work at Longsight was initially received with great interest and enthusiasm. The class responded well to the turtle graphics. After a time, Logo became an accepted part of the work of this class: the novelty wore off but the general enthusiasm was maintained. I was frequently greeted with the question, "is it our turn next?" and pupils were visably disappointed if it was not. After break-times, pupils would be found waiting at the computer ready to begin, even before the class teacher arrived. But once again, the computer activity should perhaps not take full credit for this positive pupil response: some pupils expressed their delight at being able to miss certain lessons; others appreciated the more individualized attention. However, there was one occasion when a particular group of Logo pupils was envious of their class mates' activities (Lf10), but understandably, since at this time Christmas cards were being made: the rest of the class were not "working". This feeling implied that the Logo work was not simply thought of as a "game".

After some time at the schools, I was able to gain an indication of the properties of computer applications that appealed to the children, or indeed those which infected an unfavourable reaction.

8.2 Properties Of Programs That Appeal To Children.

Of the programs I observed the pupils using at Headland school, one that inspired more favourable comments was "Map". Most of the fourth year Junior pupils thought that it was a "good" program, but almost equal numbers described it as "not easy" (Hf16). For instance, Alan, Roger and Jake (not an academically bright group; cheeky, but cheerful with it) enjoyed it despite describing it as "quite hard" (Hf16). This program is a simple instructional one. A map of the British Isles appears on the screen and the pupils are required to locate ten towns (by correctly positioning the cursor). A score of 10/10 is given for a "direct hit". If the mark is just missed, then a lower score is given. One group of pupils thought the program somewhat unfair in the scoring since it did not distinguish adequately between a near miss and a completely wrong location (Hf17). Apart from this inadequacy, the program was well received. More than one group asked if there was a time limit: one group physically relaxed when they discovered that there was not. Another group (Hf22) responded with cries of "Oh good". Programs with time limits tended to be interpreted as "tests" and caused a certain amount of stress. Without a time limit pupils were more likely to think carefully before responding. On the other hand, many children did like to see a score at the end. They seemed to like to compare their performance with others. One boy (third year Junior) based his preference on this factor, saying: "That canoe one's better ('Shooting The Rapids'). It doesn't say how long you took on this one ('Underground Escape')" (Hf78). Most groups (fourth year Juniors) found the map exercise challenging, and in comparison with other programs, "Map" was particularly well received with the more able pupils who made such comments as:- "I think the Map's best" (Hf35); "This is not as good as last week's Map program"; one program ("Number Chaser") was described by some as "boring", "easy" and "the Map was much better" (Hf33). Later, members of the same class described "LetterGrab" as "boring because it's too easy... much rather have the Map program" (Hf48). With "LetterGrab", some groups purposefully wasted time, causing the "monster" to take up chase, in an effort to make the program more challenging (Hf51).

These comments, coupled with an occasion when I tried a selection of programs with a group of children (Hf60), revealed two main points. The first is the importance of a program appearing challenging. Children tended to bore of programs that were too easy (or conversely, too hard). The second is that the programs' graphics appeared not to be of central importance; children also liked programs without sophisticated graphics, and more importantly, good graphics did not seem to compensate for poor or unsuitable programs (Hf61). Children responded best to programs that were challenging and suited their ability - good graphics were a bonus. Graphics <u>did</u> excite pupils on occasions; for instance, when using "Number Chaser", Martin, Leon and Alex (fourth year Juniors) were enthrawled with the graphics and sounds, joining in with their own "brum-brum" noises, and making comments like "we're really pulling away now" (Hf40). A group of first year Juniors were stimulated by the same graphics; they jumped out of their seats in excitement! (Hf55).

Many of the programs used at Headland utilized "rewards". It is of interest that one of the favourites, the "Map" program, did not employ such forms of external motivation. For some reason the pupils found the program challenging for its own sake, unlike programs like "Brickup" where it appeared that the pupils endeavoured to answer the crossword type clues correctly because they are rewarded with a "shot at the wall" (Hf68). (The game is "won" if a gap through the wall is made). Likewise, with "Vennman" one group requested several goes at this because, as one boy commented: "I like putting the man together" (Hf67). (The program presented Venn diagrams. A correct response assembled part of the "reward man"). This comment reveals the external motivation for the task in hand. It was also usual for the programs used at Headland school to "reward" correct responses with an encouraging sound. One program ("Story") unfortunately made a rather negative "boom" sound if the answer was correct. This lead pupils to seek reassurance that their answer was, in fact, correct.

At Longsight school it has already been seen that some aspects of the Logo work were enjoyed more than others, namely interacting with the computer rather than preplanning and writing programs (Lf23). And also, as the pupils became more proficient, it was clear that they preferred to spend time working on their own projects rather than following the Session sheets.

At Ben Mercy school, there were fewer occasions when the pupils' reactions to the computer programs were less than favourable. Except for once, all the programs I saw in use at Ben Mercy were enjoyed and/or found to be challenging. The programs were more varied in nature than the simple instructional programs in use at Headland (for instance, "Tray", "Number Painter", "Flowers Of Crystal", "Quest", "Edword", and "Viking England"). The theory that children bore quickly with programs that are unsuitable for their ability seemed to be borne out at Ben Mercy. Most often children did find the computer work challenging and did not tire of it. When I had the opportunity to try a variety of programs with a group of first year Juniors (two boys and one girl), I observed the following reactions: "Anagram" (a simple instructional program) quickly proved too easy for the group (Bf59); the group did not respond well to "Wordworm" (also seen in use at Headland). The idea of the program seemed insufficiently challenging and additionally, they found it difficult to control the "worm" (Bf60); the group liked "Marsh" (the aim is to cross the marsh, avoiding hazards - some information can be discovered about the safety of adjacent squares), although they found it difficult. They co-operated well, discussing decisions about which step to take next (Bf61); the group did not respond well to "Castle" because they found it too difficult. They bored with the program and requested something else; although an Infants' program, the group had great pleasure using "Jumbo". It amused them loading the elephant into the lorry using the crane (Bf61).

From these observations, it is important that in general, the computer program is suitable to the ability of the group. Children tired quickly of programs that were too easy, and equally, of programs that were too difficult. "Jumbo" was an exception for this group. The graphics were sufficiently amusing for the overall response of this group to be favourable.

With some programs, the graphics are an important feature for the children, as with "Jumbo". "Number Painter" is another example (the Head reported that it had been used successfully with all Junior aged pupils). The program's basic aim is to improve children's mental arithmatic. The pupils direct a little figure around the screen - up and down ladders and along platforms. They collect numbers (for example, +6, -4, x2, ÷3) to make a target total. After successfully reaching the target, they move on to another, more difficult level (higher target with fewer +/- numbers). The graphics are an essential feature, for without them it is doubtful the pupils would persevere with the program.

With other programs, children's responses to the graphics varied. At Ben Mercy, I observed groups of third and fourth year Juniors using "Flowers Of Crystal" (an adventure simulation). During the program, several "monsters" are encountered. Based on these observations, boys responded less well to the graphics, being unimpressed with the monsters (Bf9). On the other hand, groups of girls tended to describe them as "scarey" (Bf13). This sex difference had been noticed by the Headteacher. There was also a difference in the way these groups of boys and girls approached the program: the boys tended to rush about from place to place without much preplanning; the girls were more methodical and careful, though less adventurous. Girls tended not to continue when warned of danger. In contrast, groups of boys stormed ahead. As an example, one group of boys was given the message:-

"To continue would be dangerous". One asked:-
"Shall we go on?" Another proferred:-
"We might die". The third replied:-
"That doesn't matter, we don't <u>really</u> die". (Bf9).

And so they stormed on. The boys seemed to get less involved in the simulation, taking it less seriously and treating it more as a game. (The

Headteacher had found similar responses when using "Adventure Island").

It would be unwise to generalize these sex differences (one fourth year Junior boy did respond more to the graphics and planned missions to some extent Bf57), but it does suggest that care should be taken when grouping pupils.

8.3 Grouping Pupils.

A mixture of the sexes might be beneficial, although here there could be the danger that boys might dominate. But not all boys are of a dominant nature, and not all girls are passive. At Ben Mercy school, one group of three boys and one girl (Welsh third and fourth year Juniors) were observed using "Viking England" (Bf20). This group worked well. The girl was not dominated by the boys. Indeed, she offered many suggestions and was able to justify them, saying things of the sort:-

> "Hide the boats well as one has been lost", and,
> "We don't need many men to raid the monastry as the monks won't fight back". (Bf20).

On other occasions too, mixed groups were seen to co-operate well. A group of three girls and three boys (fourth year Juniors) were observed using "Tray". They were very absorbed in their work and discussed their decisions. In the "Tray" program a text is presented - at the lowest level, just some words are missing; at the highest, only punctuation is given. The text is revealed as pupils buy letters (so lowering the score) and make predications of letters and words (raising the score). This group thought hard and carefully before making predictions or buying letters. No one dominated or was left out (despite it being a large group). Of their own accord, they took turns at the keyboard (Bf27/29).

ever, another group (fourth year Juniors) using "Tray" worked less l. The two boys and four girls were dominated by one of the boys who most of the typing, although all worked on the text and called out dictions.

If pupils are thoughtfully grouped then there is likely to be ater co-operation and discussion.

At Headland school, some groups (two to four children usually) ked well together. A good group co-operated, discussing what response make and taking turns at the keyboard (for example, Hf19, three fourth : Junior girls using "Map"). Other groups were able to work operatively in such a way that was likely to lead to greater success. instance, with "Story", a fourth year Junior group divided the task of rizing text between the group members. One boy instigated this with words:-

"You remember the 'pink gate', and you remember the 'black cow', and I'll remember the 'bright May'". (Hf29).

ss academically bright group were able to employ a similar strategy; group member, Jake, suggested that "each one gets a sentence in our " (Hf31).

Other groups worked less well together. Some did not co-operate ll, rather took individual turns at the program (Hf41). Other groups dominated by one member. In one instance, one fourth year Junior boy nated the proceedings, keying in all the responses. However, one of other members of this group recognized the unfairness and demanded the others should have a go (Hf17). But other groups were seen to the dominant member keep control (Hf33). When Ralph and Mathew (third Juniors) were using "Tables Adventures", it was necessary to actively ıp Mathew taking over so that Ralph could have a turn. Had it not been · such intervention, Ralph would have simply sat back and silently ıctated (Hf80).

At Longsight school, grouping was important. The interaction :ween the two studied pairs was quite different. Both pairs worked well : for different reasons, as has been seen. I asked them what they ıught about working together at Logo. George and Norman liked working ;ether. Lisa and Everlyn were quite vocal on the subject:-

ˡ: What about working together then? .... If you had a choice, say we had more computers, would you like to work on your own or with somebody?

With somebody.

With somebody.

Yeah, because if you get stuck, then they know it, and they can get quite stuck, and you know it.

ˡ: Yes. So you prefer to work with somebody rather than on your own.

Yeah.

ˡ: Would you like to work with somebody better than you, about the same, or not so good?

About the same.

Same.

It wouldn't be much good for you if everybody was telling you everything.

ˡ: If the other person was better than you.

Yeah, they'd just be telling you everything and you would be learning a little bit...

You would learn, if they were telling you, you'd know next time.

ˡ: Yes, so you could learn from them.

I know, but they'd be doing most of the work so you wouldn't be learning very much.

}: Yeah.

With someone that's umm, doesn't know as much as you, you could help him and he wouldn't know much after.

Yeah, 'cause it's difficult for him as well. I think it's best if you're both the same.

}: Do you two like working together?

Yeah... well!... (Both laugh)

}: Is there anybody you'd prefer to work with?

Not really, no. [T8A&B:CRp251-252]

would seem that careful grouping can have certain educational rantages, as indicated in the above discussion.

With the focus on children still, from observing them using the nputer, it is possible to make comments about the benefit it may have : them and the value they place on it in the learning situation.

<u>Pupils' Impressions Of Computer Activities.</u>

For some children, the computer offers something that inspires em to concentrate and apply themselves. Teachers have remarked that pils who are disruptive in class and lack concentration work well at the cro. This is true of Bernie (a second year Junior at <u>Headland</u> nool): he was quick on the keyboard and worked at "Starspell" with ncentration, yet his teacher frequently needed to discipline him in the rmal classroom situation (Hf10). For a <u>few</u> pupils the ability of the cro to motivate is perhaps reason enough for its place in the learning rironment. For others, the computer sessions provided opportunity for -operative work as has been seen.

The computer was seen to benefit some of the less able pupils: if the program suited their ability, it gave them opportunity to build confidence. The computer was able to provide a learning situation in which less able pupils could achieve success - something unusual for some (for example the "Story" program, although unchallenging for the more able, seemed appropriate for some of the fourth year Junior class; the less able were pleased with their right answers and thought the program "brilliant" (Hf35)).

At Headland school, from comments made by the pupils, it appeared that many divorced computer work from "real" classroom work. Often, what was done at the micro was termed "a game". Commenting on the "Story" program, one fourth year Junior boy, unimpressed with it, queried: "what kind of game is this? It's boring" and later, "this is a weird game" (Hf30). On another occasion, one pupil was trying to persuade a member of the group to select a more difficult level on a program called "Number Chaser". His friend was doubtful of his ability but was encouraged with the words: "but it's only a game" (Hf41). The fourth year Juniors commonly used the word "game" in describing their reactions to programs: for instance, "LetterGrab" was described as "a nice game" by one (Hf48) and "a slow game" by another (Hf49). Pupils asked questions in such terms, as in "shall we play a new game?" (Hf80), and the feeling that the computer work was detached from other "real" classroom work was clear in Alan's (third year Junior) remark made after a computer session: "I've done no work this morning" (Hf79).

Games were evidently associated with the computer at Headland school. Virtually every time a pupil was asked what program s/he liked most, the chirpy reply came:- "Hopper" (Hf16, Hf60, Hf66). "Hopper" is a game (like "Frogger") which involves successfully negotiating rivers and roads, avoiding collisions with objects. It has little educational aim.

Such an attitude in the fourth year Junior class was unsurprising since the teacher did not integrate the computer work into the other classroom activities; nor was the computer work documented in any way. A similar attitude amongst the third year Juniors was likewise unsurprising. The second year Juniors less often described the computer activity as a game, and in this class it will be remembered that the teacher did use the programs to reinforce classroom work; additionally, she used the computer to test pupils.

From time spent at Ben Mercy school, it seems that computer work was generally not thought of as a game by the pupils. Perhaps this is because most of the work was integrated into the classroom activities (as with "Quest") or programs where more of a stand-alone nature ("Tray" and "Number Painter"). It is pertinent that pupils thought computer work more of a game when it was less clear to them why the program was being used. This is true of the "Flowers of Crystal" program which some thought of a game: at the time, the Head was trialing the program in order to see how well pupils worked at it so it was not integrated into the classroom activities. If it had been, then more pupils might have taken it more seriously.

On the basis of the evidence so far considered, it seems that pupils at the three schools had differing attitudes to the computer(s). In order to investigate this idea further, an attitude scale was developed and presented to the two top Junior classes in each school. The impressions so far gained about the children's attitudes to the computer in school are generally supported by the results of the attitude scale, which indicated that the school can affect its pupils' attitudes to the computer (over and above such factors as sex and access to computers outside school). The next sections explain the development and administration of the attitude scale and discuss the results.

8.5 The Attitude Scale.

8.5.1 Development And Administration.

Once it had been decided that an attitude scale might indicate whether the hypothesis (that children's attitudes to computer education are influenced by the approach taken by the school) was well grounded, the first task was to create a large item pool of attitude statements. Statements were composed by the author, drawing on the background literature and the contact and discussion with children who had inevitably expressed attitudes towards their school computer(s), as has been seen. Oppenheim (1966) recommends that the researcher conducts interviews for the express purpose of eliciting attitude statements. This was thought to be unnecessary since considerable time had already been spent with the children and an impression of the variety of attitudes had been formed, as well as an appreciation of the language used by the pupils in the area.

During compilation of the large item pool, care was taken to try to make statements uncomplicated and simply understood: effort was made to avoid language that was ambigious or too difficult for the age group to understand.

The author was interested in a range of aspects of the microcomputer in school and so statements (see pages 280/1) were included that covered:-

-the computer in relation to the curriculum (for example, item 14: "I think you can only use computers for learning maths.")

-computers and learning, and whether using them is thought to be hard or easy (for example, item 16: "It's easy to learn from the computer")

-the personal desirability of using the computer (for example, item 10: "I'd rather not use the computer")

-the usefulness of computers in school (for example, item 11: "Computers are useful things to have in the classroom")

Other items which did not strictly fit into these categories were also included because they seemed interesting in themselves (for example, item 25: "Computers don't understand children").

The initially large pool of items was reduced to 28 as a result of discussion with tutors, although a process of piloting and statistical analysis is the recommended procedure (Oppenheim, 1966) for eliminating unsuitable statements. However, as the process of factor analysis was used for refinement of the pool of items, this pilot procedure was believed to be unnecessary.

The final 28 statements (see pages 280/1) were arranged on the answer sheet which allowed the respondent to tick one of three boxes, either "agree", "not sure" or "disagree". It was considered whether a 5-point scale ("strongly agree", "agree", "neither agree nor disagree", "disagree" and "strongly disagree") should be used but it was generally thought that it would be unsuitable for the age group and even problematic for some (for instance, the less able nine year olds).

The final 28 statements were balanced in the sense that equal numbers of positive and negative items were included. These statements were then randomly arranged on the final list (see pages 280/1). The question sheet was completed by the top two classes (J3 and J4) in the three schools, making a total of 149 respondents. The following table provides a break down of the respondents by school and class:-

S C H O O L	C L A S S J3 (9-10)	 J4 (10-11)	Percentage of respondents at each school.
Longsight	28 (some J2 as mixed class)	27	36.91
Ben Mercy	23	22	30.2
Headland	26	23	32.89
Total	77	72	

Total number of pupils: 77 + 72 = 149.

The attitude scale was presented to a whole class at a time, after explaining that it was not a test - it was not even necessary for them to write their name on the paper (which many found unusual). Before the papers were handed out, two points were made clear; firstly that there were no right or wrong answers so each pupil should respond truthfully, and secondly, that each should not copy a neighbour's answers. The first few statements were then read out individually, allowing time for the respondents to make their selection. Pupils then continued on their own, asking for help as necessary, although sometimes all statements were read out. It was thought that too many difficulties would be encountered (particularly by the less able) if the questionnaire was simply handed out and the children left to get on with it; as it was, the odd statement was probably misread, and errors made in ticking the intended box; a few put two ticks for one statement, and none for the next.

After responding to the 28 statements, the pupils were asked to complete a few further background questions:-

Date of Birth: ..../.........../..... I am ...... years old.

(would there be differences between age and attitude?)

Are you a:- ☐ girl or ☐ boy? (please tick box)

(would there be gender differences?)

Do you use a computer out of school:-

☐ never

☐ about once or twice a year

☐ about once a month

☐ about once a week

☐ about once a day.

(would the attitude be affected by the use of a computer out of school?)

The researcher recorded which school the respondents attended.

This produced a significant quantity of data which was then subjected to statistical analysis. First, the attitude questionnaire was studied for frequency. After this, it was factor analysed.

8.5.2 **The Frequency Scores.**

Before the statistically significant results of the factor analysis are examined, it is interesting to look at the frequency scores of the attitude statements, displayed on the following pages.

	% AGREE	% NOT SURE	% DISAGREE
(1)Only clever children should use the computer.	5.4	10.1	84.6
(2)Computers can't help me in English or Welsh lessons.	18.1	41.6	40.3
(3)I learn a lot from the computer in school.	73.2	20.1	6.0
(4)Computers can be used in all school work.	39.6	43.6	15.4
(5)Using the computer in school is hard.	18.8	18.1	63.1
(6)I learn best with the computer.	17.4	39.6	42.3
(7)Computers worry me.	5.4	8.1	86.6
(8)Using computers makes me feel clever.	34.9	29.5	35.6
(9)I learn better from the teacher than from the computer.	59.1	20.8	20.1
(10)I'd rather not use the computer.	1.3	8.7	89.9
(11)Computers are useful things to have in the classroom.	89.3	5.4	4.0
(12)I don't learn much from the computer.	7.4	14.1	77.2
(13)Computers in school are fun	93.3	4.0	2.0

(14)I think you can only use computers for learning maths.	2.7	7.4	89.3
(15)When I use the computer, it often makes me feel stupid.	4.7	10.7	84.6
(16)It's easy to learn from the computer.	54.4	32.2	13.4
(17)I like using the computer in school.	95.3	4.0	0.7
(18)I think computers are useless.	1.3	1.3	97.3
(19)I'd prefer to learn without using the computer.	7.4	28.9	63.1
(20)Computers are exciting.	89.3	7.4	3.4
(21)Computers can help me with all school work.	32.2	40.9	26.8
(22)Using the computer in school is boring.	0.7	7.4	91.9
(23)I'd like to spend more time using the computer in school.	77.2	17.4	5.4
(24)I think computers are important in school.	65.1	24.2	10.1
(25)Computers don't understand children.	24.2	36.9	38.9
(26)Computers make school better.	81.2	10.7	8.1
(27)Computers are just for playing games.	6.7	5.4	86.6
(28)Computers make me think	79.2	14.1	6.7

2.7% of respondents were aged eight; 33.6% aged nine; 43% aged ten and 20.8% aged eleven. 45% were girls and 55% were boys. The following shows the percentage response to the "use of computer outside school" question:-

18.1% never

8.7% about once or twice a year

11.4% about once a month

24.8% about once a week

34.9% about once a day

The scores for each of the attitude statements show the percentage of pupils "agreeing", "disagreeing" and "not-suring". The first statement ("only clever children should use the computer") produced encouraging percentage scores; 84.6% disagreed with this statement. Other statements (including statements 7, 11 and 14) provided similarily encouraging results. The study of the frequency scores for other statements reveals an interesting distinction some pupils seemed to be making. The first notable score was that of statement 5, "using the computer in school is hard"; 18.8% and 18.1% of the population "agreed" and were "not sure" respectively, i.e. nearly 37% were inclined to think that using computers was hard. Similarly, it might have been expected that more then 54.4% would agree that "it is easy to learn from the computer" (statement 16). Perhaps these results are not surprising. Yet, in relation to the frequency scores of other statements, they are at least thought provoking. For instance, consider the score on statement 10, "I'd rather not use the computer": it might be expected that roughly equal percentages would agree with this that had agreed with statement 5; i.e. children who tend to find using the computer less than easy would rather not use it. But this expectation is not fulfilled: a resounding 89.9% disagreed with this statement. Likewise, if statements 13 ("computers in school are fun"), 17 ("I like using the computer in school") and 20 ("computers are exciting") are considered, a similar picture emerges. Perhaps it might be postulated that quite a number of pupils (in the region of 30%) are making a distinction between "enjoying" the computer (finding it fun and exciting and liking using it) and seeing it as presenting challenges in learning (not finding it easy to use). But on the other hand, it might be that these children "enjoy" using the computer because they do not connect it with learning; in this sense they might not think it is easy to learn from the computer because they do not consider that what they do at the computer is "learning".

Further frequency scores are of interest. Some of the scores may be used to support the suggestion that as a whole, children seem to be somewhat uncertain of the way in which the computer fits in with their school work and curriculum (perhaps their uncertainity reflects that of the teachers). The vast majority (86.6%) do not agree that "computers are just for playing games" (statement 27); nor do the majority (89.3%) think that "you can only use computers for learning maths" (statement 14). Yet fewer than half think that computers can help them in their English or Welsh lessons (statement 2) and only 39.6% agree that "computers can be used in all school work" (statement 4); most were "not sure". In fact, of the 28 statements, this one attracted the greatest percentage in the "not sure" option. The children seem to believe that the computer in the classroom is more than just for playing games, and not only for maths work. Yet many seem to doubt its use in language and other school work. But perhaps this simply reflects the different applications children have encountered in the three component schools.

One further result issuing from the frequency scores of each of the variables, is worthy of comment. In response to the question, "do you use the computer out of school", the largest percentage went for the option "about once a day" (34.9%). If this option and another, "about once a week", are combined then almost 60% can be said to use the computer out of school at least once a week. But what they are used for is another issue altogether and one which was not investigated here due to constraints of time.

A brief examination of the frequency scores has provided some information about children's attitudes to computers in primary schools. The attitude scale was also factor analysed. This provided further information.

8.5.3 The Factor Analysis.

8.5.3.1 What Is Factor Analysis?

The 28 statements used in the attitude test reflected different aspects of attitudes to computers in school. Statements were included that covered the computer and learning, the personal desirability of using computers, computers and the curriculum and the usefulness of micros in school. The purpose of factor analysis is to simplify and order.

> "The single most distinctive characteristic of factor analysis is its data-reduction capability. Given an array of correlation coefficients for a set of variables, factor-analytic techniques enable us to see whether some underlying pattern of relationships exists such that the data may be 'rearranged' or 'reduced' to a smaller set of <u>factors</u>." (Jae-On Kim, 1975, p469).

The statements are analysed in such a way that factors are revealed.

Factor analysis places the items into groups of highly related statements. This is done by intercorrelating all the items. As a result, the statements fall into a number of relatively distinct groups, each of which represents an aspect of the general attitude being studied, or a "factor". A "factor" has been provisionally defined by Child (1970):-

> "When a group of variables has, for some reason, a great deal in common a factor may be said to exist. These related variables are discovered using a technique of correlation." (p2).

To illustrate, Child (1970) offers an example:-

> "....if one took a group of people and correlated the length of their arms, legs and bodies one would probably find a marked relationship between all three measures. In other words, tall men tend to have long arms and long legs and vice versa for short men. This interconnection constitutes a factor - a factor, if you like, of linear size." (p2).

In order to carry out the factor analysis, all the data was coded: all the information contained in the answer sheets was reduced to numbers{1}. This information was put on U.C.N.W.'s DEC mainframe computer system, making use of the Statistical Package for the Social Sciences (SPSS). Rather than detailing the complex mathematical techniques employed during factor analysis, greater emphasis will be placed on interpreting the results. However, the factor analysis process will be briefly outlined.

3.5.3.2 Extracting, Establishing and Naming The Factors.

The first problem in factor analysis is deciding how many factors to extract. There are several methods that may be employed to make this decision. Two common methods are Kaiser's Criterion and the Scree Test. Kaiser's Criterion: This method uses the eigenvalue to indicate how many factors should be extracted. The eigenvalue (sometimes called the latent root or extracted variance) is the sum of squares of the loadings on the factor due to all the statements (variables) (Child, 1970, p42). It represents an index of how much variance that factor represents in terms of the total variance{2}. With Kaiser's criterion, the number of factors is given by the number having an eigenvalue greater than 1. The following eigenvalues and percentages of variance{3} were given for this data:-

FACTOR	EIGENVALUE	PCT OF VAR
1	4.96333	17.7
2	2.50804	9.0
3	2.01988	7.2
4	1.96599	7.0
5	1.52874	5.5
6	1.36033	4.9
7	1.13447	4.1
8	1.09337	3.9
9	1.02174	3.6
10	0.92984	3.3
11	0.83840	3.0
12	0.77493	2.8
13	0.75221	2.7
14	0.73229	2.6
15	0.70504	2.5
16	0.69306	2.5
17	0.63322	2.3
18	0.58133	2.1
19	0.54064	1.9
20	0.48231	1.7
21	0.46636	1.7
22	0.41281	1.5
23	0.39638	1.4
24	0.37754	1.3
25	0.30834	1.1
26	0.28700	1.0
27	0.27425	1.0
28	0.21817	0.8

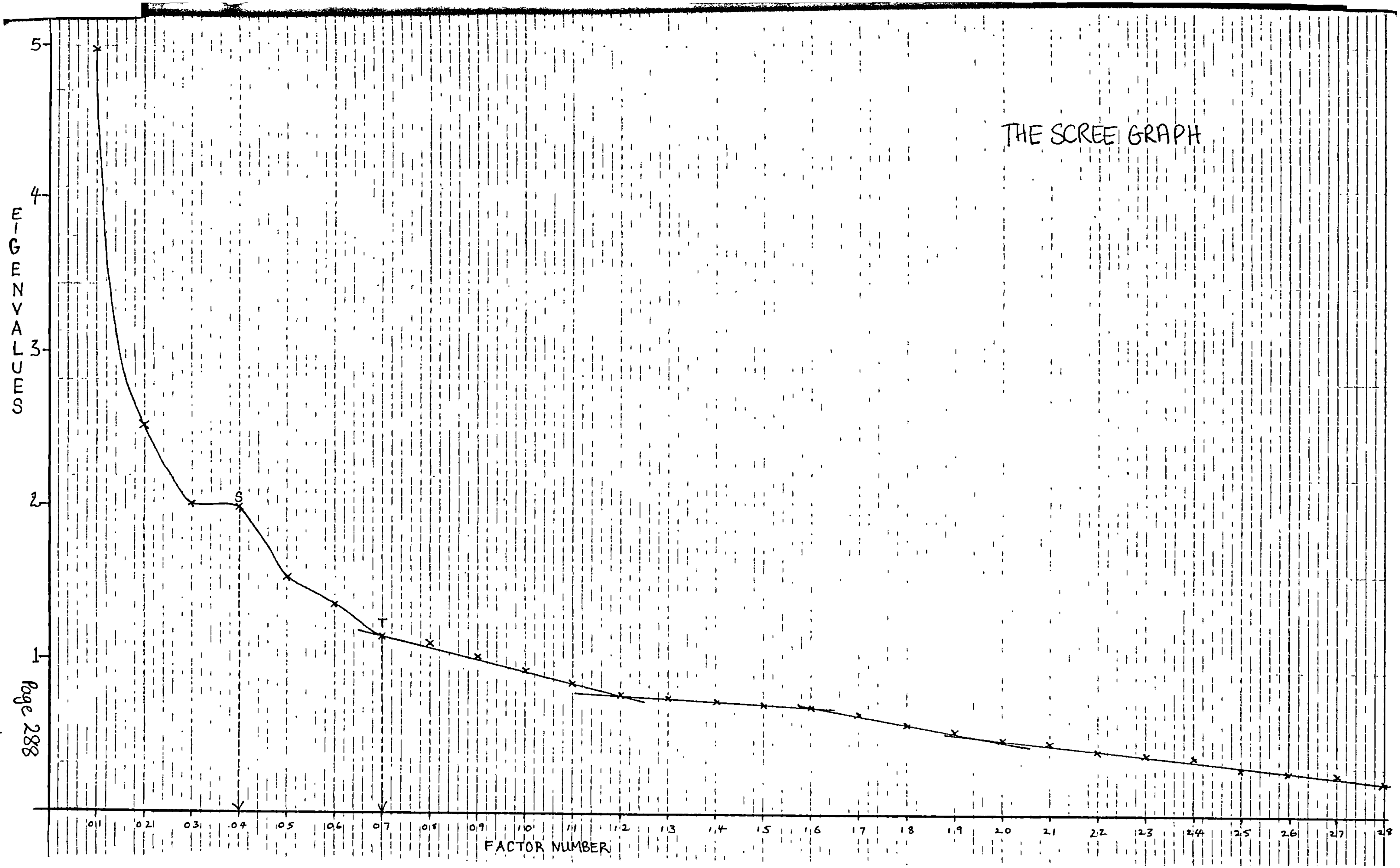
If this method had been adopted in this case, then 9 factors would have been extracted. Indeed, Cattell (1966) recommends that Kaiser's Criterion is most suitable for analyses having 20 - 50 variables (statements); if there are fewer variables, then too few factors tend to be extracted, and if there are more than 50, then too many tend to be extracted. However the nine factors that demanded extraction by this method was thought to be unnecessarily large for the number of statements. The PCT OF VAR{3} (the percentage of variance) given in the table above, shows that Factor 1 accounts for a large (17.7%) amount of the total general attitude.

Further study of the PCT OF VAR lends support to the suggestion that an extraction of nine factors (as indicated by Kaiser's criterion) is too many, since, only five factors have a PCT OF VAR greater than 5%. Also, when a nine factor analysis was examined, five of the nine factors had fewer than three statements (using a significant loading of greater then +/- 0.35 as explained later). An alternative method for deciding how many factors to extract was then considered.

The Scree Test: With this method, the eigenvalues are plotted against factor number (i.e. the order of extraction). The resulting graph is used to indicate the number of factors to be retained. The graph forms a curve which tends to straighten out. If a line is drawn from where the curve straightens out to the factor number, then the number of factors to be extracted can be read off. The Scree graph is so called since it resembles a hill with rubble at the bottom, geographically termed "scree".

In this research, the graph shown on the following page was obtained. It is a fairly typical scree graph: the bump towards the left (S) is quite usual. However this method also does not clearly indicate the exact number of factors to be extracted. It is questionable exactly where the graph straightens out and the scree begins. Is it at point S (indicating 4 factors), or at point T (indicating 7 factors), or does the graph indicate another number of factors?

THE SCREE GRAPH



Deciding how many factors to extract caused some problems. The Scree graph did not seem to support a nine factor analysis as indicated by Kaiser's criterion). The bump at S could indicate the beginning of the scree. This would suggest that four factors should be extracted. In addition, the percentage of variance seemed to indicate that only a few factors would be important, since most of them took up such a small part of the whole variance. The first four of the 28 factors accounted for more than 40% of the total variance. Four and five factor analyses were first examined. In each case, significant loadings were taken to be greater than +/- 0.35 (as explained later). The five factor analysis only produced four common factors; the fifth factor contained just one statement. It seemed sensible to reject this five factor analysis. The four factor analysis distributed a reasonable number of statements in each factor. This analysis looked promising.

These four groups of statements were studied to see what attitude was indicated by each. On first sight there seemed to be a problem since factors two and three looked very similar. For this reason it was decided to look at the three factor analysis to see if statements in the factors would be redistributed. However, nothing helpful was learned from this; a more parsimonious solution was not easier to interpret. The three factor analysis produced a similar pattern to the four factor analysis; factors two and three were still quite alike. The three factor analysis was rejected in favour of the four factor analysis more strongly indicated by the Scree graph. Once again, it was necessary to return to the Scree graph. Perhaps the scree began at point T, indicating seven factors. Nothing would be lost by examining the seven factor analysis. But the result was not promising: factors three, four and six had fewer than three statements. This did not mean that they were unique (a factor is "unique" if it has just one significant loading), but they did seem somewhat indistinct. Therefore, basically by a process of elimination, the best choice seemed the four factor analysis. This choice was made cautiously.

Having discussed how it was decided how many factors to extract, it needs to be explained how the component statements for each of the four factors was established. Using the varimax "orthogonal" method (contained in the SPSS) a matrix was produced giving the loadings of all the statements (V1 - V28) on each of the four factors. The following "rotated" (as opposed to "initial") factor matrix was produced:-

	FACTOR 1	FACTOR 2	FACTOR 3	FACTOR 4
V1	0.08840	-0.01499	-0.08837	0.68296
V2	0.17363	-0.50129	-0.07561	0.13443
V3	0.22027	0.00030	0.44584	0.16616
V4	0.02480	0.53406	0.11811	-0.27463
V5	-0.03959	-0.16720	-0.00801	0.44056
V6	0.13428	0.57578	0.05035	0.03896
V7	-0.05120	0.08545	0.15184	0.40962
V8	0.16323	0.44735	-0.05124	0.15233
V9	-0.01826	-0.52491	-0.04028	0.03617
V10	-0.44954	-0.12006	-0.13056	0.02728
V11	0.47163	0.02816	0.17732	0.03729
V12	-0.37477	-0.26341	-0.55083	0.09868
V13	0.53518	-0.07781	0.03542	-0.21886
V14	-0.08474	-0.09405	-0.08765	0.24573
V15	-0.18210	-0.13451	0.35478	0.13387
V16	0.21853	0.42417	-0.02170	-0.01530
V17	0.65670	0.07970	0.16155	0.07677
V18	-0.47700	0.19680	-0.06460	0.36843
V19	-0.54500	-0.09600	0.16097	0.21726
V20	0.53732	0.11776	-0.12409	0.03668
V21	0.23231	0.59685	0.05782	-0.11470
V22	-0.62622	-0.08363	0.02681	-0.02299
V23	0.49371	0.28484	-0.39681	-0.22806
V24	0.40873	0.19115	0.12865	-0.06246
V25	-0.25007	-0.12077	-0.10475	-0.04837
V26	0.52989	0.06114	0.04645	-0.06324
V27	-0.21891	-0.18081	-0.54395	0.25462
V28	0.02963	0.12022	0.45275	-0.20985

From this matrix, statements can be put into groups by studying the loadings. A decision has to be made as to what loading value should be considered significant (so assigning statements with this value or greater to the factors). As has already been indicated, a loading of +/- 0.35 was taken to be significant in this case. Two of the more common methods influenced this decision.

[1] Based on the experience of factor analysts, a rule of thumb has developed. Loadings are considered significant if they are greater than +/- 0.3, as long as the sample is greater than 50.

[2] An alternative method employs the Burt-Banks Formula. Burt and Banks have shown that:-

> "as one progresses from the first factor to higher factors the acceptance value for a loading to be judged significant should increase." (Child, D., 1970, p46).

Using the formula, they developed a table for calculating the significant loadings for various numbers of variables. For example, if a test has 30 variables then, to be significant at the 1% level, the loadings in the first factor need to be greater then +/- 0.346, increasing to greater than +/- 0.403 for the ninth factor (Child, 1970, p99).

This particular research accepted a loading of greater than +/- 0.35, influenced by both the above methods. The precise minimum figure of the loading is not greatly important, since in naming the factors those with greatest loading (often in the region of 0.6+) are of greatest significance.

After assigning the statements to the factors, by examing the loadings, the next step was to name the factors.

A first useful step in naming a factor is to arrange the statements with loadings greater than+/- 0.35 in order so that the highest loading is placed at the top. The loadings with the greatest value give the strongest indication of the attitude the factor is concerned with. Factor one (in the four factor analysis decided upon), produced the following loadings (to two decimal places) over +/- 0.35:-

VARIABLE NUMBER	LOADING		STATEMENT
No.17	+0.66	:	I like using the computer in school.
No.22	-0.63	:	Using the computer in school is boring.
No.19	-0.55	:	I'd prefer to learn without using the computer.
No.20	+0.54	:	Computers are exciting.
No.13	+0.54	:	Computers in school are fun.
No.26	+0.53	:	Computers make school better.
No.23	+0.49	:	I'd like to spend more time using the computer in school.
No.18	-0.48	:	I think computers are useless.
No.11	+0.47	:	Computers are useful things to have in the classroom.
No.10	-0.45	:	I'd rather not use the computer.
No.24	+0.41	:	I think computers are important in school.
No.12	-0.37	:	I don't learn much from the computer.

What label can be given to this factor? Naming factors is not a straightforward business. This factor is "bipolar" since it contains loadings that are both positive and negative. This indicates that the factor:-

> "embodies contrasting groups of variables.... A bipolar factor can be labelled in one of two ways. Either it is described in terms of the significant variables at the poles of the factor or in terms of a single nomenclature which appropriately describes the continuum from one pole to the other." (Child, D., 1970, p48/9).

The highest loading is positive, and is:-

No.17 +0.66 : I like using the computer in school.

The highest negative loading is:-

No.22 -0.63 : Using the computer in school is boring.

This factor expresses a range of attitudes from the most positive (liking computers and finding them fun and useful) to the most negative (finding computers boring and useless). Key words in this factor are of an affective and emotional nature, expressing the personal desirability of using computers ("like", "exciting", "fun", "boring"), and utility ("useful", "useless", "learn without"). This factor might tentatively be called, the <u>"affective" attitude to computers in school</u>.

<u>Factor two</u>, had the following loadings over +/- 0.35:-

VARIABLE NUMBER	LOADING		STATEMENT
No.21	+0.60	:	Computer can help me with all school work.
No.6	+0.58	:	I learn best with the computer.
No.4	+0.53	:	Computers can be used in all school work.
No.9	-0.52	:	I learn better from the teacher than from the computer.
No.2	-0.50	:	Computers can't help me in English or Welsh lessons.
No.8	+0.45	:	Using computers makes me feel clever.
No.16	+0.42	:	It's easy to learn from the computer.

This is another bipolar factor, though there is an emphasis on positive loadings; the highest loadings are all positive (+0.60, +0.58, +0.53). The highest negative loading is -0.52. If there had been more negative statements then the full bipolarity might have been reflected. The statements with negative loadings ("I learn better from the teacher than from the computer"; "Computers can't help me in English or Welsh lessons"), may more closely reflect the school situation, rather than representing a purely "anti-computers-in-school" attitude. As for naming this factor, the words of the statements clearly express concern with learning and school work. They express the pupils' attitude to the usefulness of computers specifically for learning. This is a difficult factor to interpret in a single word or short phrase. Factor two's basic concern is <u>the utility of the computer in school learning</u>.

<u>Factor three</u> had the following loadings over +/- 0.35:-

VARIABLE NUMBER	LOADING	STATEMENT
No.12	-0.55 :	I don't learn much from the computer.
No.27	-0.54 :	Computers are just for playing games.
No.28	+0.45 :	Computers make me think.
No.3	+0.45 :	I learn a lot from the computer in school.
No.23	-0.40 :	I'd like to spend more time using the computer in school.
No.15	+0.35 :	When I use the computer it often makes me feel stupid.

Factor three is more clearly bipolar, expressing the range of attitudes from positive through to negative, although the highest two loadings are negative (-0.55, -0.54). But overall, this six statement factor has a balance of positive and negative loadings and statements. This is another difficult factor to label. On first inspection, it is similar to factor two: on closer study, factor three is less specifically concerned with school learning. Factor three is more general. For example, "Computers make me think" is a more general statement than those appearing in factor two. This factor also expresses the extreme views, ranging from, "Computers are just for playing games", to "I learn a lot from the computer in school". Factor three seems to be concerned with <u>the utility of the computer in a general sense</u>.

Factor four had the following loadings over 0.35:-

VARIABLE NUMBER	LOADING	STATEMENT
No.1	+0.68 :	Only clever children should use the computer.
No.5	+0.44 :	Using the computer in school is hard.
No.7	+0.41 :	Computers worry me.
No.18	+0.37 :	I think computers are useless.

This is clearly not a bipolar factor. All statements load positively. This statement is relatively easy to interpret. It expresses a negative attitude to computers (for example, "Using the computer in school is hard"). This factor is concerned with statements expressing a general desire to avoid using the computer. Factor four might be labelled "avoidance motivation".

It may also be worth noting that three statements occurred twice; variable number 12 (in factors one and three), variable number 18 (in factors one and four), and variable number 23 (in factors one and three). Two statements did not produce significantly high loadings to appear in any of the factors; these were variable numbers 14 ("I think you can only use computers for learning maths") and 25 ("Computers don't understand children"). Statements which do not correlate with any of the factors may be either inappropriate for the test (and should be discarded in later tests) or interesting, but idiosyncratic.

Naming factors is not a straight-forward task. The exercise highlights one of the possible limitations of factor analysis, namely that labelling factors is a subjective business and open to alternative interpretations. There is also the danger of trying to "squeeze" the factor into some single-worded or short-phrased title.

The factor analysis categorized the 28 statements concerning various attitudes to computer education, into four separate, but related, factors. Having completed the inspection of the factors, it now remains to examine and interpret the significance results.

8.5.3.3 **Results And Interpretations.**

The frequency scores have already been looked at: points of interest were noted. The factor analysis shed further light on children's attitudes to computers in education. The main hypothesis behind this piece of research was that the different approach each case study school took to computer education affected pupils' attitudes towards micros. For instance, it was anticipated that the Ben Mercy pupils would have a more "positive" attitude than the Headland pupils. Additional concerns were whether or not the sex of the pupil affected attitude to computers (did girls and boys attitudes differ?); whether age made a difference, and whether access and use of computers outside school affected attitudes to micros. All four factors were analysed with each of these variables, sex, age, use of the computer out of school, and school. For this, the Student-Newman-Keuls (S-N-K) "a posteriori" multiple range test was used (contained in the SPSS), except for sex, which was an either/or (boy or girl) question, not multiple range. The S-N-K test examines the relationship of every mean with every other, and indicates whether or not there is significant difference.

8.5.3.3.1 **Sex And Age Differences.**

The first thing worth noticing is that statistical difference between the age or sex of the pupil, and any of the factors was not present.

The following results were obtained for <u>sex</u>, using Student's t-test:-

	MEAN	STANDARD DEVIATION	2-TAIL PROB. OF T-TEST pooled var. est.
FACTOR 1			0.204
girls	-0.1183	0.624	
boys	0.0841	1.124	
FACTOR 2			0.521
girls	0.0573	0.830	
boys	-0.0373	0.892	
FACTOR 3			0.325
girls	0.0990	0.906	
boys	-0.0449	0.814	
FACTOR 4			0.540
girls	0.0527	0.714	
boys	-0.0342	0.918	

The Factor analysis compared the four factors with the variable sex. For results to be significant, the 2-tail probability values need to be less than 0.05; these clearly are not, so, on each of the four attitude factors, there was no significant difference between boys and girls. This result is encouraging, if somewhat surprising.

The following results were obtained for age:-(The pupils were aged 8, 9, 10 or 11 thus giving 4 groups. The Degrees of Freedom between groups is given by the number of groups minus 1).

FACTOR 1	D.F.	SUM OF SQUARES	MEAN SQUARES	F RATIO	F PROB
between groups	3	0.9435	0.3145	0.354	0.7860
within groups	136	120.6616	0.8872		
total	139	121.6051			

Multiple Range Test — Ranges for the 0.05 level
Student-Newman-Keuls — 2.81 3.36 3.38

=> NO TWO GROUPS ARE SIGNIFICANTLY DIFFERENT AT THE 0.05 LEVEL.

FACTOR 2	D.F.	SUM OF SQUARES	MEAN SQUARES	F RATIO	F PROB
between groups	3	0.4255	0.1418	0.187	0.9050
within groups	136	103.0884	0.7580		
total	139	103.5138			

Multiple Range Test — Ranges for the 0.05 level
Student-Newman-Keuls — 2.81 3.36 3.38

=> NO TWO GROUPS ARE SIGNIFICANTLY DIFFERENT AT THE 0.05 LEVEL

FACTOR 3	D.F.	SUM OF SQUARES	MEAN SQUARES	F RATIO	F PROB
between groups	3	2.5017	0.8339	1.139	0.3356
within groups	136	99.5582	0.7320		
total	139	102.0600			

Multiple Range Test Ranges for the 0.05 level
Student-Newman-Keuls 2.81 3.36 3.38

=> NO TWO GROUPS ARE SIGNIFICANTLY DIFFERENT AT THE 0.05 LEVEL

FACTOR 4	D.F.	SUM OF SQUARES	MEAN SQUARES	F RATIO	F PROB
between groups	3	0.6317	0.2106	0.300	0.8251
within groups	136	95.3303	0.7010		
total	139	95.9620			

Multpile Range Test Ranges for the 0.05 level
Student-Newman-Keuls 2.81 3.36 3.38

=> NO TWO GROUPS ARE SIGNIFICANTLY DIFFERENT AT THE 0.05 LEVEL

From these tables, it might be assumed that, in this particular sample, attitude towards the school computer was not affected by whether the child was 8, 9, 10 or 11 years old, or whether the child was a girl or a boy. This latter finding is of particular interest since other research suggests that boys tend to dominate the school computers and that generally girls are disadvantaged in the technological field, (Hughes et al, 1984; Siann & Macleod, 1986). Such findings are not generally supported by this research since the girls and the boys appeared to have similar (not significantly different) attitudes to computers. However, one piece of research by Harvey and Wilson (1985) did produce supportive results:-

> "The results overall revealed very little sex difference, very little difference between primary- and secondary-school children, but a difference between owners and non-owners. Perhaps the most interesting result was the lack of sex difference." (p187).

In this research, frequency of computer use outside school produced some significant results. However, the school variable provided the greatest number of significant results. This suggests that schools can powerfully affect the attitude children have to micros in the classroom. The school variable affected the way children viewed computers more than the other variables. But before these results are examined, those relating to computer use out of school will be explored.

8.5.3.3.2 **Frequency Of Computer Use Outside School.**

The first, second and fourth factors (attudes) did not produce significant results; no two groups were significantly different at the 0.05 level. Significant results were found for the third factor. The following table shows the results obtained for frequency of computer use outside school (number of groups = 5 since there were 5 possible responses to the use of computer outside school questic (see p279 (note that results for Factor 4 are shown before those for Factor 3, as the former were non-significant):-

	D.F.	SUM OF SQUARES	MEAN SQUARES	F RATIO	F PROB
FACTOR 1					
between groups	4	4.1246	1.0312	1.191	0.3177
within groups	132	114.2690	0.8657		
total	136	118.3936			

Multiple Range Test	Ranges for the 0.05 level			
Student-Newman-Keuls	2.81	3.36	3.68	3.91

=> NO TWO GROUPS ARE SIGNIFICANTLY DIFFERENT AT THE 0.05 LEVEL

	D.F.	SUM OF SQUARES	MEAN SQUARES	F RATIO	F PROB
FACTOR 2					
between groups	4	1.1718	0.2929	0.385	0.8193
within groups	132	100.5302	0.7616		
total	136	101.7020			

Multiple Range Test	Ranges for the 0.05 level			
Student-Newman-Keuls	2.81	3.36	3.68	3.91

=> NO TWO GROUPS ARE SIGNIFICANTLY DIFFERENT AT THE 0.05 LEVEL

FACTOR 4	D.F.	SUM OF SQUARES	MEAN SQUARES	F RATIO	F PROB
between groups	4	0.8453	0.2113	0.319	0.8651
within groups	132	87.5424	0.6632		
total	136	88.3877			

Multiple Range Test — Ranges for the 0.05 level
Student-Newman-Keuls — 2.81 3.36 3.68 3.91

=> NO TWO GROUPS ARE SIGNIFICANTLY DIFFERENT AT THE 0.05 LEVEL

FACTOR 3	D.F.	SUM OF SQUARES	MEAN SQUARES	F RATIO	F PROB
between groups	4	8.4049	2.1012	2.963	0.0221
within groups	132	93.5974	0.7091		
total	136	102.0023			

Multiple Range Test — Ranges for the 0.05 level
Student-Newman-Keuls — 2.81 3.36 3.68 3.91

=> (*) DENOTES PAIRS OF GROUPS SIGNIFICANTLY DIFFERENT AT THE 0.05 LEVEL

Mean	Use of Computer Outside School		Use Of Computer Outside School (2)	(1)	(5)	(4)	(3)
-0.1923	Once/twice a year	(2)					
-0.1818	Never	(1)					
-0.0851	Once a day	(5)					
+0.1146	Once a week	(4)					
+0.6319	Once a month	(3)	*	*	*		

The third factor (concerned with the utility of the computer in a general sense) provided an F probability of 0.02 (to the nearest two decimal places), showing three significantly different pairs at this level: from the F probability, one can be more than 98% confident that these pairs had significantly different attitudes to the usefulness of the computer in a general sense. The attitude concerned with the utility of the computer in a general sense seems to be affected by the frequency of the use of the computer outside school. This may not be surprising, but the specific results are more so. What do these results mean?

Those who used a computer out of school once a month (3) had a significantly different attitude to the general utility of the computer than those who used it once a week or more frequently (4 and 5). The mean attitude score for using the computer once a month is high (+0.6319) indicating more "disagree" responses to the statements in this factor (since a score of 3 was given to a "disagree"), but this factor is bipolar, so it cannot be said from the factor analysis alone that the mean indicates a more "negative" attitude. However, it might be anticipated that those who use the computer once a week or more often would have a greater sense of the general utility of the computer, than those, who presumably have access to the computer, but only use it once a month. A large percentage (59.7%) of pupils used the computer once a week or more often, and, from looking at the frequency scores for the statements in factor three, the majority response showed an appreciation of the utility of the computer in a general sense (for example, 77.2% disagreed with statement 12, "I don't learn much from the computer"). It could be suggested that those who use it once a month have a more "negative" attitude since their responses differed significantly from the majority. Perhaps the more frequent the use of a microcomputer out school, the greater the child's sense of its general utility.

However, the results also show a significant difference between those who never use a computer out of school (1) and those who use one once a month (3). This finding seems to conflict with the previous one: it does not support the hypothesis that the more frequently a computer is used out of school, the greater the users' sense of its general utility, since those who never use it out of school also have a significantly different sense of its general utility than those who use it once a month. However, an explanation can be proffered which ties in with the above:

maybe those who never use a computer out of school would dearly desire to, but are unable to for financial reasons, for instance; perhaps in discussing a possible purchase they have become aware of its great potential usefulness. In contrast, those who use a microcomputer out of school about once a month, presumably do have access to the equipment, and yet <u>only</u> use it once a month. And the lack of a sense of the computer's general utility might explain why these children do not use it more frequently.

Other significant results concerned the different schools.

8.5.3.3.3 **Schools And Attitudes To Computers.**

The first factor (reflecting the affective attitude) had an F probability of 0.3665, so no groups were significantly different at the 0.05% level. The following table shows the results:-

(Number of groups = 3; Headland, Ben Mercy and Longsight)

FACTOR 1	D.F.	SUM OF SQUARES	MEAN SQUARES	F RATIO	F PROB
between groups	2	1.7689	0.8845	1.011	0.3665
within groups	137	119.8362	0.8747		
total	139	121.6051			

Multiple Range Test — Ranges for the 0.05 level
Student-Newman-Keuls — 2.81 3.35

=> NO TWO GROUPS ARE SIGNIFICANT AT THE 0.05 LEVEL.

However, on the remaining three factors, significant difference was shown between schools. These will be examined in turn.

<u>Factor 2</u> (the utility of the computer in school learning).

FACTOR 2	D.F.	SUM OF SQUARES	MEAN SQUARES	F RATIO	F PROB
between groups	2	5.8238	2.9119	4.084	0.0189
within groups	137	97.6901	0.7131		
total	139	103.5138			

Multiple range test — Ranges for the 0.05 level
Student-Newman-Keuls — 2.81 3.35

=> (*) DENOTES PAIRS OF GROUPS SIGNIFICANTLY DIFFERENT AT THE 0.05 LEVEL

Mean	School	School (2)	(1)	(3)
-0.2485	Ben Mercy (2)			
-0.0031	Longsight (1)			
+0.2629	Headland (3)	*		

The F probability of 0.0189 shows that it is possible to be about 98% confident that there are significant differences between the schools indicated on the table above. The table shows that the pupils at Headland school had a significantly different attitude to the use of the computer in school learning than did those at Ben Mercy school. More children at Headland school "disagreed" with the statements in factor two (since the positive mean indicates more 3-scores, coded for "disagree") and more pupils at Ben Mercy "agreed" with the statements in factor two (since the negative mean indicates more 1-scores, coded for "agree"). The factor is bipolar (although it does contains more "pro" computer statements than "anti" ones) so it is not possible to say from the factor analysis alone that one school's attitude was more "positive" than the other's. However, if the factor analysis is considered in conjunction with the frequency scores for factor two, there is the suggestion that Ben Mercy school pupils had a greater sense of the utility of the computer in school learning than did pupils at Headland. If the statement with the highest loading in factor two is considered ("computers can help me with all school work"), then agreement indicates a more "positive" attitude, and the factor analysis indicates that a significant number of Ben Mercy school pupils is represented in the 32.2% "agree" figure.

If this interpretation is valid then these results are not surprising to the researcher. As has already been seen, the application of the micrcomputer at Headland school was largely confined to the use of drill-and-practice programs, usually reinforcing basic maths and language work. In contrast, the computers at Ben Mercy school were deployed more broadly; as well as using some reinforcement programs (including one for learning to read music), the computers were employed in project work which involved information handling amongst other things. It was anticipated that Ben Mercy pupils' attitude to the usefulness of computers in school learning would be more positive than the Headland pupils' attitude.

<u>Factor 3</u> (the utility of the computer in a general sense).

FACTOR 3	D.F.	SUM OF SQUARES	MEAN SQUARES	F RATIO	F PROB
between groups	2	11.7302	5.8651	8.895	0.0002
within groups	137	90.3298	0.6593		
total	139	102.0600			

Multiple Range Test　　　Ranges for the 0.05 level
Student-Newman-Keuls　　　2.81　　3.35

=> (*) DENOTES PAIRS OF GROUPS SIGNIFICANTLY DIFFERENT AT THE 0.05 LEVEL

		School (1)	School (2)	School (3)
Mean	School			
-0.3246	Longsight (1)			
+0.0579	Ben Mercy (2)	*		
+0.3731	Headland (3)	*		

The F probability of 0.0002 reveals that it is possible to be 99.99% confident that there are significant differences in the attitude to the use of the computer in a general sense between the schools indicated on the table above. The table reveals that the pupils at Longsight school had a significantly different attitude to the use of computers in a general sense than the pupils at both Ben Mercy and Headland school.

The negative mean score for Longsight school indicates more "agree" responses to the statements in factor three. Factor three is bipolar so it is not possible to say from the factor analysis alone that this indicates a greater appreciation of the utility of the computer in a general sense. From the frequency scores for the statements in factor three, the great majority of pupils showed an appreciation of the utility of the computer in a general sense. This makes interpretation difficult. From experience at the schools, it is not too surprising to find a significant difference between the schools of Longsight and Headland, the reasons for which should already be clear. It is more surprising to find a significant difference between Longsight and Ben Mercy (although the mean values reveal that the difference is more marked between Longsight and Headland). Longsight was largely a Logo school, whereas Ben Mercy school applied the computer more broadly. The significant difference regarding the general utility of computers could be explained by the lack of variety of computer uses children experienced at Longsight. And perhaps more children at Longsight used the computer out of school about once a month (see the section on the significant differences between the factors and use of computer out of school). However, from the frequency scores, many pupils at Longsight must also have had an appreciation of the general utility of computers. Two points could explain this. The first is that the pupils at Longsight school followed a television series about the broader applications of computers in everyday life. The second is the unquantifiable influence of the staff at the school and the parents at home. Particularly on this factor, concerned with the general utility of computers, children's attitudes might have been affected in a number of ways, by a number of experiences and people.

Factor 4 (avoidance motivation).

FACTOR 4	D.F.	SUM OF SQUARES	MEAN SQUARES	F RATIO	F PROB
between groups	2	4.6011	2.3006	3.450	0.0345
within groups	137	91.3609	0.6669		
total	139	95.9620			

Multiple Range Test Ranges for the 0.05 level
Student-Newman-Keuls 2.81 3.35

=> (*) DENOTES PAIRS OF GROUPS SIGNIFICANTLY DIFFERENT AT THE 0.05 LEVEL

		School		
Mean	School	(1)	(3)	(2)
-0.2338	Longsight (1)			
+0.1236	Headland (3)	*		
+0.1602	Ben Mercy (2)			

The value of the F probability is 0.0345 indicating that it is possible to be about 97% confident that there are statistically significant differences in the avoidance motivation attitude between the schools marked on the table above. The results show that the pupils at Headland school had a significantly different avoidance motivation attitude to those at Longsight school. Although Ben Mercy school's mean value is greater than Headland's, no significant difference was shown between Longsight and Ben Mercy perhaps because the variance in the scores is greater in Ben Mercy than in Headland. As far as Longsight and Headland are concerned, the mean values show that more of the pupils at Longsight school "agreed" with the statements in this factor. This would seem to indicate that, taking the statement with the highest loading, significantly more pupils at Longsight thought that "only clever children should use the computer" than those at Headland (although the frequency scores show that only 5.4% of all pupils "agreed"). At one level this can be interpreted as meaning that the Longsight pupils had a "negative" attitude to the computer. However, on a different level, it might suggest that the way in which the microcomputer was used was in some way hard or difficult, requiring some cleverness in the children. This need not be interpreted negatively. The children using Logo at Longsight did at times find the work difficult, but should this be a criticism? Children sometimes find more difficult tasks more challenging. On the other hand, to think that only clever children should have a go is surely not a desirable attitude. This result was somewhat surprising, but in the light of the case study information, it can be explained partly.

8.5.3.4 **Conclusions From The Factor Analysis.**

A general conclusion from this piece of research alone is difficult to draw. The factor analysis has thrown up a number of results, but interpretation is not straight-forward particularly with bipolar factors. However, it does seem that the school inflicts a powerful influence on its pupils' attitudes to the microcomputer, more powerful than sex or age; more powerful than outside access to computer(s). The implications of this pervasive influence could be far reaching. A major way in which this "school influence" is communicated is likely to be through the use made of the microcomputer, however, other influences (from parents, computer use outside school, teachers' attitudes communicated via the hidden curriculum) must also affect a pupil's overall attitude to the school computer(s).

In addition, any forthright conclusions should perhaps be avoided since criticism can also be levelled at the attitude scale and factor analysis which might render the results less significant.

8.5.3.5 **Criticisms Of The Factor Analysis.**

This piece of research involving an attitude scale and factor analysis, although providing some interesting and valuable results, is open to criticism, as is any research technique (especially those used with such comlex subjects as people). Some of these criticisms have already been mentioned.

The final results may have been affected by the pupils "faking good", making responses that they believed were the most "desirable". For instance, a child who never uses a computer out of school might have chosen the "once a week" box, thinking this response more desirable. This problem of social desirability may never be overcome completely. In this research, attempts were made to lessen the problem; upon presentation of the attitude scale, it was emphasized that the exercise was not a "test" and that names were not needed on the papers. However, as already mentioned, results might also have been affected by the children making errors in the marking of the boxes on the attitude scale - some might have accidently ticked a box they had not intended to choose.

Other criticisms surround the selection of the number of factors and their labelling, two points at which subjectivity can enter into the research. The number of factors selected affects the findings: slightly different results are likely to have occurred if, for instance, seven, not four factors had been selected. Consequently, it is advisable to present the reader with details of how decisions were reached. In so doing, an explanation of the decision reached is presented, and also enough data to allow others, who might disagree, to formulate their own decision.

A further criticism is the question of reliability. If the attitude scale had been given to the children on a different occasion, would the same findings have resulted? Perhaps the children's responses on that particular occasion were affected by a recent enjoyable and successful computer session, or conversely, an unpleasant one. There is no sure indication of the stability of the results over time.

Likewise, if generalizations to wider populations were made, it can be asked how representative the sample was of school children in general. It may be that if three other schools had been selected, in a different area, then different findings may have resulted. The generalizability of the results could be questioned.

8.6 Summary And Conclusions.

Considerable attention in the case study report has focused on teachers. However, it was also thought to be important to examine the pupils in the schools and their attitudes to microcomputers. Chapter Eight has addressed this concern.

Some of the findings, regarding children's attitudes to computers, are encouraging: the response was usually enthusiastic, and some of the frequency scores revealed quite an open attitude to computers. A further encouraging finding was the absence of significant difference, in the factor analysis, between girls and boys, and different aged pupils. The factor analysis, in general, was found to support impressions gained from time spent with the pupils. Perhaps the most important finding was that the school can clearly influence pupils' attitudes to computers. Of course, there are many questions lying behind the findings, and an array of explanations for each, but the results would seem to indicate that schools are in a postion to influence pupil attitude, and this could have far reaching effects. It is the school pupils of today who become the decision makers of tomorrow.

However, it is important to view the statistical analyses of the attitude questionnaire (and all the investigation into children's responses to computers) as part of a greater study of the purpose and value of microcomputers in primary education. The attitude questionnaire provided some interesting results; these are better understood if considered as one part of the more detailed picture of the schools: Chapters Six, Seven and Eight should be viewed together, not in isolation. The final Chapter will draw together all these parts and consider the future of computer education in these three schools, and more broadly, in the primary sector in general.

Chapter Eight: Notes.

{1} (see page 285).
The input variables were coded in the following way:-
V1-V28...Attitude statement scores (28 single digit numbers).
1 = agree; 2 = not sure; 3 = disagree.
V29......Age (two digits, 08, 09 10 or 11).
V30......Sex (one digit).
1 = girl; 2 = boy.
V31......Use of computer outside school (one digit).
1 = never; 2 = about once or twice a year;
3 = about once a month; 4 = about once a week;
5 = about once a day.
V32......School (one digit).
1 = Longsight; 2 = Ben Mercy; 3 = Headland.

{2} (see page 285).
The total variance of a factor is usually referred to as the communality of that factor. It is the sum of the loadings on each of the statements.

{3} (see page 286).
PCT OF VAR (percentage of variance) gives some idea of how much of the total variance each factor takes, and:-

> "the higher this figure is, the more substantial can be the claim that the items with significant loadings have some property in common." (Child, D., 1970, p42).

PART FOUR:

CONCLUSIONS.

Chapter Nine: THE FUTURE OF MICROCOMPUTERS IN PRIMARY EDUCATION.

Chapter Two expressed the anticipation that the way the computer is used in primary schools is based on certain assumptions - assumptions about education, about the nature of the learner and about the content and method of the curriculum. However, the empirical research (described in Chapters Six and Seven) revealed that many teachers apparently divorced the computer from "education": often it was a case of "we've got this machine so we'd best use it". And when it came to deciding how to use it, most often the computer simply ran the programs that were to hand. Little or no thought was given to the computer's educational purpose or the software's implications for practice. It is doubtful that the teachers simply assumed that the software they had to hand was of some educational value since it is unlikely that they even considered it in such terms. Very imprecise and non-explicit intentions were being pursued by teachers in their employment of the computer. And for this reason it is difficult to provide a summary of the state of "computer education" in each of the three case study schools.

However, from the empirical research, it is clear that at Headland the computer was not being used to improve the quality of the educational processes offered by the school. "Computer education", as understood in this thesis, was not being fostered in practice. A reading of the case study report reveals some of the many complex variables that have contributed to this, but principally it can be explained by a lack of reflective thought, resulting in disillusionment. The microcomputer at Headland school was seen to be, to coin a phrase, "innovation without change".

Ben Mercy school presented a much brighter picture. Here the school was concerned with improving the quality of the educational experiences it offered pupils; it had a reflective Headteacher who was able to explore the varied educational potential of the computer. At Longsight school, the Logo work showed one way a computer may be used that could lead to genuine educational progress. However, as has already been indicated, its future acceptance and integration into the school is dubious.

In a word, the message from the case study report is "non-correspondence": there was little evidence to suggest that computer uses corresponded to the schools' educational philosophies. No particular educational rationale was being explicitly adopted, or avoided, for the microcomputer. This says something about the role of schools' "philosophies", as expressed in official documents: although they describe schools' educational ideals, they rarely operate to guide classroom practice. But it says something about computer education as well. What it makes abundantly clear is that the expansion has not been due, primarily, to educational reasons or developments. The main reason why computer use in primary schools has increased dramatically since the early 1980s (as schools acquired the hardware) is not that computers can improve the quality of the educational activities of primary schools. Rather, it has come about for a number of other reasons. These relate to increased pressure (from the general public, industry and government bodies) who worry about a new society in which computers are common place and pervasive: the pressure is on schools to prepare their pupils for a place in such a society. But this pressure has non-educational roots: the expansion of computer use in schools has too often been due to technological rather than educational concerns. This issue is pursued in section 9.4 of this chapter.

The case study report revealed a considerable lack of "computer education", illuminating instead the chaos and complexity. However, since there was no model of computer education, no tradition or habitual practice, this "revelation" is perhaps not surprising. The three schools were at the stage of exploration. A key question is, "will these early days of exploration serve as a sound foundation for later decisions regarding the future direction of educational computing?". Doubt and indecision was voiced about the future. A number of teachers not only did not know what to do with the computer(s), but also wondered why they _should_ do something. It is apparent that the value of this exploratory period is dependent on a number of factors. The attitude of teachers is clearly a factor. They complained of restraints and problems. Indeed all schools have faced, or are facing difficulties. The factors affecting the success or otherwise of educational computing can be delimited.

9.1 Computer Education In Primary Schools: Barriers To Success.

Certain factors inhibit computer education in primary schools. The success of educational computing, as understood in this thesis, is assessed in terms of its contribution to the improvement of the quality of the educational processes of the school. Certain barriers to the successful integration of the microcomputer into the aims and values a school's curriculum can be identified. Some of these are fairly obvious and practical but others are of a more fundamental and entrenched nature. The factors having greatest effect (or, reasons that contribute to a rejection of the computer) may be considered under two main headings, namely, practical/technical barriers, and fundamental/entrenched barriers.

9.1.1 **Practical/Technical Barriers.**

Under this heading, the following will be considered: problems of resources (including hardware, software, time and money), and organization.

9.1.1.1 **Resources.**

The problem of resources is a major factor affecting educational computing. Resources is a term which covers many things and can be sub-divided into hardware, software, time and money resources. There are obvious overlaps, particularly between hardware and software, and money, but this factor is more easily considered if sub-divided.

9.1.1.1.1 **Hardware.**

The number of pupils per micro is an obvious factor which could restrict its use. Many of the teachers in the case study schools complained of lack of equipment - often there were insufficient computers to service the school. The Headteacher at Longsight said:-

> "....in a school of our size - 170 pupils... one computer between so many children, the amount of time a child can have on the keyboard - actually on the computer - is very, very small." (Li13)

Additionally, the reliability of the computers, or rather the lack of it, can cause problems. Machines, particularly if they have been switched on all day and have been "carted" about the school, are liable to be faulty at times. Such a faulty microcomputer was not an infrequently observed occurrence (Lf15, Lf16, Lf27 - although admittedly, these faults lay with the solidisk). A faulty computer can be an expensive and time consuming problem for those schools without back-up services.

The accessibility of the hardware can also be problematic. The physical lay-out of the school may restrict the movement of the computer between classes, because of steps and separate buildings. A lack of power points could also limit where a computer is set up. There can also be problems with security: if the computer is locked away at night it can be a daily chore to set it up, and this alone could be enough to deter a reluctant user.

Most early microcomputer purchasers chose a cassette-tape recorder, not a disk-drive. This choice had serious repercussions for the future. The complaints about tape machines are widespread. The Longsight Headteacher voiced this common complaint:-

> "...programs on tape aren't very satisfactory, especially when children are attempting to load and, perhaps the first run doesn't work, one has to go through it all again - some programs can be as long as five minutes to load... this wasn't very satisfactory... a disk-drive.. makes the computer more versatile in the school." (Li1/2)

It is a wonder that the schools coped at all without a disk-drive, and it is not at all surprising that many teachers were deterred from using the computer. Those teachers who awaited the micro's arrival with high expectations were quickly disillusioned with the tape machine. And by the time the school had adequate funds to purchase a disk-drive, some teachers had been permanently discouraged. A cassette-tape player was hardly an endearing feature of the computer set-up. Not only is it true that simply putting microcomputers into schools will not result in their automatic use, so also is it true that if the first use is problematic/unsatisfactory then it is less likely that they will be used further or that the initial obstacles will be surmounted.

Other peripherals, or rather the lack of them, can also limit computer education. For example, to fully benefit from word processing, a printer is needed. Younger pupils especially, can gain more from the micro if the school has a concept keyboard, or turtle.

The lack of adequate resources, in terms of hardware, can seriously limit the amount and quality of educational computing. However, perhaps it should be questioned whether the schools are making full use of the hardware resources they do have. And if they are not, software is often blamed.

9.1.1.1.2 **Software.**

As with cassette-tapes, early poor quality software may account for a certain amount of disillusion amongst teachers. In the early days, in the words of the Ben Mercy Headteacher, there was a lot of "rubbish" about: he personally would not be surprised if microcomputers were not used much in the future because of off-putting experiences with poor programs on cassette-tape (Bf63/5). He also spoke of a problem peculiar to Gwynedd: the county M.E.P. centre had concentrated its effort on the translation of programs into Welsh; there is nothing wrong with that in itself, but it had led to delays and a preponderance of poorer quality software because the simplist programs were easier to translate (Bf62). This had held the county back for a time.

A lack of quality software, particularly for infants, was a common complaint:-

> "There isn't anything suitable for children just starting school." (Hf84/6).

Such comments were justifiable in the early days because there was a paucity of good software. The situation has since improved, but there is still a problem, namely that of evaluating and selecting from the software market. A teacher at Headland school said that software catalogues were "useless" (Hf86) - it was not possible to learn enough from them to make a wise selection. The Headteacher at Longsight made a similar comment:-

> "...The evaluation of materials is very difficult, very pricey... with books one can... borrow or buy books on a sale or return basis... It's not quite the same with computer programs." (Li16).

It can be difficult for teachers to select software, but it can be hoped that not everyone adopts the attitude of one of the teachers at Headland school; he believed that the school needed someone to write programs for them (Hf51). What is disturbing is that he lacked knowledge of what was currently available. This teacher could have at least given further thought to broadening his knowledge of software before concluding that they needed a programmer to write personalized material for the school: it could be used as an excuse for not exploring further. However, this criticism should be tempered by the recognition that evaluating software does take time, and time is a valuable resource and in short supply.

9.1.1.1.3 **Time.**

Everything to do with the microcomputer takes time. It takes time to set up; it takes time to learn how to use; it takes time to acquaint oneself with each piece of software; it takes time to learn how to use new peripherals. And this is perhaps the resource of which teachers are most short. Unfortunately, poor quality programs take less time to translate, and also less time to get to know. The Headteacher at Ben Mercy commented that the more potentially rewarding programs take longer to become familiar with. Such software is also more likely to require careful lesson planning (Bf58). Logo is an obvious example: although it is possible to work with Logo just one step ahead of the children, learning continues over a considerable period of time. Additionally, lessons need a certain amount of preparation, particularly in the early stages. The Ben Mercy Headteacher commented:-

> "....I'm sure that if one had the time to sit down and really work out the material, I'm sure we could get a lot out of Logo - otherwise, until such time is available, I doubt very much if we are going to be able to do much with Logo, except on the very, very simple first level basis. (Bi14).

The Quest work is another example: the Ben Mercy Headteacher simply concluded: "I wish we'd got more time" (Bi7). He recognized that teachers lack time to explore (Bf65). Basically he did most of the exploring and passed on his knowledge to the staff. But he acknowledged that keeping up to date with the developments is really a full-time occupation - he wished he had a secretary to free him from routine administration so giving him more time to work with micros, teachers and children (Bi17).

Clearly then, lack of time can hinder the progression of computer education. Ben Mercy Head said:-

> "There is just not enough - I want to explore many computer avenues but am frustrated by the lack of time". (Bf75).

A very similar thing could be said of money.

9.1.1.1.4. **Money.**

Little need be said for lack of funds is most often the root cause of all resource problems. Interestingly, the Headland Headteacher said that lack of funds prevented the purchase of more software but added:-

> "Too much has been spent already." (Hf84).

This is further evidence of his disillusion.

Many of those involved in education are only too painfully aware of what could be achieved with better funding for hardware and software purchases, and importantly, in-service training. The limited financial resources of schools can contribute to limited computer education.

From all this, it should be clear that resources alone can impeed the furtherance of computer education. However, the organization and management of the microcomputer, as will be seen, can go some considerable way towards alleviating these difficulties.

9.1.1.2 **Organization.**

Although not a problem in itself, certain ways of organizing the computer in primary schools can enhance or impeed its use. From visiting schools it would seem that a common way of organizing assess to the computer(s) is by timetabling. The Headteacher at Ben Mercy school started off with such an organization (as mentioned earlier, p143) but later changed the arrangement. The school acquired more computers, but rather than timetabling these, one remains in the Infants' department, one in the Junior, and one in the Head's office (for administration and small group work). Within the two departments, a priority basis operates whereby it is up to each teacher to make a case for using the computer. The original arrangement was changed because of what the Head saw as a major drawback of computer timetabling, namely that teachers are alloted a fixed time with the computer and do not always want it then, and are often unable to access it when they do want to use it. Timetabling is perhaps not the best arrangement. It is possible that without a timetable the computer(s) will be used less often, or by fewer teachers, but what use is made of the equipment is likely to be more thoughtful, productive and hopefully, educational.

Another way to overcome some of the resource problems is to have a teacher "in charge", or responsible for the computer(s). At Ben Mercy school, the Head performed such a role. The other case study schools did not have such a position, although Longsight Headteacher commented:-

> "....I think it is important that there is someone in the school who is conversant with what is possible with the machine". (Li15)

And about my work with Logo he said:-

> "....we were fortunate... in that we did have an 'expert' (in inverted commas) here... It's nice having one person responsible for this." (Li7).

Likewise, after a visit, one of the teachers at Headland school expressed her appreciation of having someone with the children whilst they were working on the micro (Hf57).

The benefit of having a teacher responsible for microcomputer use has been recognized by Ellam and Wellington (1987), who write:-

> "Schools with someone in charge are more likely to have purchased additional computers, disc drives, concept keyboards and the like. Having an expert or someone in charge is also likely to promote better computer use because software is more likely to be organized, catalogued and therefore more accessible." (p44).

Even if one particular teacher has not been appointed to such a position, it would be helpful if, at the stage of running through programs, a few notes are made for further reference and for assisting others who might later use the software. As was apparent at Headland school (Hf65), it is often not possible to tell what is involved with the program from its name alone. And sometimes programs have been "acquired" with no background information.

The overall organization of the microcomputer(s) could also relate to what goes on at the secondary school level. For instance, if Logo is in use at the local secondary school in the first year, this could, to some extent, guide the feeder primaries. Some computer work with older pupils might be aimed at preparing for micro use at secondary school. Whether this is a good thing is debatable and in any case teachers were heard to complain about the lack of follow-on at secondary school. Teachers at Headland school reported that pupils do not meet the micro at secondary school until the third year (Hf3, Hf20). One teacher reported that children loose their enthusiasm for computers as they do not see them again for so long (Hf50), but added, interestingly:-

"...in any case, they're more concerned with academic work there."

This is an odd comment which seems to imply that this teacher divorced computer work from academic work. Also, although primary teachers may recognize the lack of computer use at some secondary schools, they perhaps should be wary of critisizing others before they have their own house in order. And, is it not rather a case of "passing the buck", regarding the decision as to what use to make of the micro, if directives from the secondary level are awaited? But this is perhaps a minor point: more importantly, it should be clear that organization, in terms of the management of the microcomputer(s) (whether to employ a timetable, or appoint a teacher in charge) will affect the development of computer education.

9.1.2 **Fundamental/Entrenched Barriers.**

Resourcing and organization are factors of a largely practical and technical nature. The solutions to such problems are not difficult (though not so easy to realize since they usually depend on the generosity of those controlling the finances). Factors that will be considered here (human factors and the problem of non-correspondence) are of a more fundamental and entrenched nature. These problems are much more difficult to remedy, both in the prescription and success of the "cure".

9.1.2.1 **Human Factors.**

Teachers' reactions to the computer, coupled with the amount of human guidance and support they have, is arguably the most powerful factor affecting the development of computer education.

Teachers have responded to the microcomputer in a variety of ways. The case study report includes a number of different reactions: apprehension and fear, enthusiasm, scepticism, reflection, disillusion, narrow-mindedness and its counterpart, open-mindedness. Both the Headteachers at Ben Mercy and Longsight made similar comments regarding their staffs' reaction to the computer. Ben Mercy Headteacher said:-

> "....most of the people on the staff had never used a computer; most of them were very suspicious of it." (Bi4).

And Longsight Headteacher reported that his staff thought it was just a luxury and something that wasn't for them.

From observation, it did seem that the "suspicious", "reluctant" attitude was more common than the "enthusiastic" response amongst teachers. The Ben Mercy Headteacher spoke of the first problem:-

> "Initially, obviously, the reluctance." (Bi18).

Here the indication is that he was not surprised at the teachers' rather apprehensive initial reaction, but he added:-

> "....funnily enough, not from older staff but from the younger staff - that I find very strange - the people who use the computer least of all (...) are the two youngest members of staff." (Bi18).

And both these Headteachers said how difficult it was to encourage sceptical members of staff:-

> "Persuading the.... staff to use it in various ways, isn't perhaps the easiest thing to do." (Li3).

However, these schools were at least fortunate to have open-minded Headteachers. The same could not be said of Headland school. A negative attitude to computers in a Headteacher is particularly unfortunate since, unsurprisingly, the Head's opinion can sway the rest of the staff. The influence of the Headteacher is a major factor affecting educational computing. A sceptical or narrow-minded Head may dampen the responses of others and an unwillingness, in any teacher, to try something new, can hamper the explorative progress.

Encouragingly however, opinions can change. Longsight Headteacher thought it was "important" to have a teacher with enthusiasm:-

> "Once you're got someone with enthusiasm, I think then this enthusiasm will rub off on to other members of staff." (Li17).

An enthusiastic member of staff can encourage the rest and is more likely to overcome the many problems that arise. But there is the danger of over reliance on this one person, just as there is the danger of over dependence on an appointed teacher "in charge". It should not be the responsibility of any one individual to enlighten the rest, without support. More teachers should have opportunities to attend courses.

The lack of in-service training courses and guidance in general was complained about in all three schools (Hf2/3, Bi4, Li2/3...). Under the Government scheme, teachers from all schools should have attended at least an introductory course. The Headteacher at Longsight commented:-

> "I was fortunate, fortunate in that I did attend some initial courses for teachers on the computer - and this of course helped me over the first hurdle in using the computer." (Li2/3).

But he added:-

> "The initial thing (course) was just setting the computer up and loading programs... from cassette." (Li3).

Although these courses helped to familiarize teachers with the equipment, they lacked educational direction: their benefit to computer education is questionable. But teachers did have to start somewhere, although it was particularly unfortunate that the initial courses usually used cassette players. However, as the Ben Mercy Headteacher explained, many schools had staff who had not attended any course:-

> "....in any school which has a computer under the Government scheme there should be at least two teachers, or certainly one teacher, who've been on an introductory scheme, and they're looking for the cascade effect whereby that one goes back and preaches the gospel. The problem at the moment is that there are still I believe something like 60 or 70 schools in Gwynedd who have got computers where again, because of the Action, the teachers haven't been on introductory courses." (Bi19).

The teachers' Industrial Action (1985/6) and the limits it placed on attendance at training courses was an added problem in the earlier days of educational computing.

Training courses are, however, only one aspect of support and guidance. If many teachers were unable to attend courses, it might be hoped that they had easy access to other sources of guidance. As has been discussed, the M.E.P. did indeed produce a considerable amount of material which was distributed to schools in the time that it functioned (until March 1986). At the L.E.A. level, counties responded differently to the introduction of microcomputers in primary education. The Ben Mercy Headteacher complained (Bf63) that, certainly until 1986, Gwynedd had just one adviser responsible for primary and secondary maths and computing. It requires little conjecture to realize that a teacher in a primary school stood small chance of support from this source. However, since the introduction of Centre schools in Gwynedd, the county support has increased considerably.

The human factor, in the sense of teacher reaction and amount of guidance and support, is perhaps not only a very influential factor but also one whose limitations should be addressed if the prospects of computer education are to improve. Another yet more fundamental and entrenched problem is that of non-correspondence.

9.1.2.2 **The Problem Of Non-Correspondence.**

From the case study report, there was clearly a lack of correspondence between the way the computer was used and the school's, or individual teacher's educational philosophy, and, it is most likely that this explains why the computer is not integrated into the curriculum. If the computer is in tune with the school philosophy then it is likely that its educational value and the implications of its use have been considered, and that there will be further innovation and integration in the future. On the other hand, if the computer is at odds with the school philosophy, then disillusion and/or non-integration are the likely outcomes. There was non-correspondence of computer use with the school philosophy at Headland and, to a lesser extent, at Longsight: Headland Headteacher became disillusioned; Longsight computer work was not integrated into the curriculum. Ellam and Wellington (1987) report similar observations:-

> "In the majority of schools and classrooms visited the method of organization was to select one program, usually one with a general appeal for the children in the class, to load it and then to let all the children use the same program"....and... "for many teachers and children, work on the computer is a separate activity." (p45).

And such observations led these researchers to the realization that, although:-

> "the majority of schools visited appeared to have an informal, child-centred approach... few schools had reached the stage where the child-centred concept had been adopted in respect of the microcomputer." (p45)

This brings to light a major concern of this thesis, namely the general lack of thought about the relationship between the different computer uses and the educational values they either endorse or undermine. Some correspondence between educational values and classroom practice is essential if the notion of computer education is to have any real meaning. This issue is taken up in a later section (9.4) in which the future of computer education in the primary school is discussed in greater depth.

How school policies regarding computer education will be affected by the GERBill (the Great Educational Reform Bill) with its recommendations for primary school testing at the ages of seven and eleven, is a question that will have to be faced in the none-too-distant future. For the present, this rather unpleasant prospect will be largely ignored in the next section where the future of computer education in the three case study schools is anticipated, in the light of the case study report and the recognition of certain barriers to success.

9.2 The Future Of Computer Education In The Three Schools.

The previous section has indicated that the future of computer education in primary schools is dependent on a number of factors. It may be interesting now briefly to speculate what will happen to educational computing at the three case study schools.

From what has been reported about Headland, the future of computer education looks none-too-bright. Many factors are in evidence, including the use of poor quality software, lack of guidance and support, non-correspondence and disillusionment amongst staff, in particular, the Head. I asked him about the plans for educational computing at his school, and he responded with the words:-

> "It's a question of funds.... We spent too much money on the machine as it was. We took up the offer with the D.T.I., but it cost us over £300. And now you can pick them up for much less. It was all a big con. They must have known about this." (Hf84).

The Headteacher was very disillusioned and felt bitter about the money "wasted", but further, he seemed to believe that some high level conspiracy was in operation. He felt, on reflection, that the school had been "conned" into getting the microcomputer, and since having it, he had not been impressed by it. As far as a Headteacher manages the school budget, computer education at Headland does not stand much chance of prospering. The Headteacher said:-

> "If there are any funds left over, then some software might be bought." (Hf84).

I suspect that computer use at Headland will gradually dwindle: indeed, after the main data gathering period, I contacted the school to arrange another visit. The Head made efforts to dissuade me and I formed the clear impression that not a great deal was being done with the computer

(Hf84/6). If computer education does develop at the school it will be without the enthusiastic support of the Headteacher.

From what has been presented so far, a completely different picture of computer education may be envisaged for the future at Ben Mercy school. The Headteacher at Ben Mercy is becoming increasingly involved with educational computing. For one thing, as has already been mentioned, the school is one of twelve strategically placed Centres in the county. The Head explained that the main function of the Centre schools is:-

> "as a clearing house for software, also as a hub - if you can imagine each one acting as a hub within a little catchment area of its own, it would be up to the individuals running those Centres, or responsible for those Centres, to decide, from local knowledge, on what is the best avenue to pursue within that catchment area; for example, there might be an interest in word processing in one, in which case they'd probably develop along those lines, and so on. And we will be available for people to inspect software, copy copyable software and to give advice when we are in a position to do so." (Bi2/3).

He thinks the Centre schools are a good idea but reckons that there should be more places where teachers can go along and view programs and see what is available (Bf65).

The Headteacher has also become increasingly involved with the M.E.U. (Microelectronics Education Unit) in Gwynedd and the work on crossing the primary/secondary divide. The work was reported in the T.E.S. (20/11/87):-

> "The Gwynedd project, based in Ysgol Syr Thomas Jones and the primary schools in its catchment area, will establish a shared database of information on the local environment." (p34).

Ben Mercy is one of the catchment primary schools. The Headteacher's involvement in the project is central since he had the original idea and he has been seconded for two days a week on the project, co-ordinating the work of the nine primary schools. Indeed, since the main data gathering period, this Head has become quite a central figure in local primary computer education. During the fieldwork he spoke of his plans, some of which have already come to fruition. His intentions show his real concern for educational computing. Firstly, he spoke of immediate plans:-

> "Immediately, we'd like to look into the use of a computer for word processing, partly because it's one of the areas we haven't done so far, and partly because the Local Authority seems very keen that we do have a look at it" (Bi12) .... "That's one thing; other plans: I would dearly love to do a lot more data-processing generally. Again, it will depend on what becomes available. We're trying to build up various files of stuff here, but I think we will have to rely on commercially available stuff eventually. Also we've got into simulation - the teachers like doing simulation exercises - and I think that's half the battle - if they enjoy it then they're going to put more enthusiasm into it." (Bi13).

This latter comment reveals the Head's concern to involve the staff and his recognition that it is not always easy and, from his experience, adventure simulations have been successful in arresting teachers' interest and enthusiasm. But to return to plans, he outlined further intentions:-

> "immediate plans are yet again to expand our library of software; that's always a top prioity. We're on the look out, all the time, for good software." (Bi15).

Little comment is needed to show how this view contrasts with that of Headland's Headteacher! Ben Mercy's Headteacher continued:-

> "I'd like to get particularly the Infants' department used to using the concept keyboard... I would also dearly like to be able to find the way of getting a modem into school... because I think it's got great potential in other areas (than data handling), even simulations... although it sounds rather esoteric at this stage, but a modem would be a very valuable thing for most schools... I'd love to get my hands on one of those." (Bi15) .... "I'd like to see a situation whereby schools could get in touch with each other down-line using their computers so we could interchange data, so we could build up databases on a county basis or whatever." (Bi19).

But he forsees problems using modems, not in terms of the initial cost, rather in the responsibility of paying the on-line charges:-

"...the initial £100 to £150 is neither here nor there, it's who pays for the use of the thing when it's on-line. And I can imagine, at times of enthusiasm... you could end up running up terrific bills on this." (Bi16).

The difference between the Headteachers at Headland and Ben Mercy is quite astounding: it is likely that the Headland Headteacher has never heard of a modem when, at Ben Mercy the Head is critically assessing its viability.

Some might expect that all these plans would require a considerable number of computers; the Head does not think so:-

"I don't think I'd want any more computers as such - possibly one more... I would like to have three which could go round the school - instead of two and a bit at the moment, but beyond that I don't think I would need any more of those." (Bi17).

This does seem quite a modest request, in terms of initial funding, but this is not quite the whole picture for he adds:-

"What I would like to find in schools is a lot more peripherals - I'd love to have a turtle, I'd love to have a concept keyboard, a modem, as I've already said, and oh, the list is endless... It's a question of how far the money goes, but again, we come back all the time, what we really need is plenty of good software as a top priority every time." (Bi17).

The Head is very vocal about what he would like to see in terms of future computer use in his school. It is of value to quote him further:-

"I'd like to see computers taken far further into the curriculum... I'd like to see for example my computer looking after my telephone and things like that... I'd like to see children able to grow up alongside computers growing up - if you know what I mean - as we get things like voice synthesisers - I'd dearly love to expand - we've got a little electronic keyboard here - I'd dearly love to have the money to couple that to the computer and have a real go at it because we've got the expertise in school, musically - I think we could do some fantastic work. Again, it's a question of money..." (Bi19/20).

The Headteacher appears to be full of ideas and certainly has a knowledge of the potential of microcomputers in primary education. A question which does spring to mind, however, is the extent to which the plans would be followed if it was not for the guidance, support and expertise of the Headteacher. Ben Mercy school is an example which again reveals the importance, and indeed, the impact of a Headteacher on the whole development of computer education in the primary school.

The future of educational computing at Longsight can also be anticipated, but within certain restrictions. In many senses, Longsight school was a special case because of the university involvement with the Logo project. Hence, it is more difficult to anticipate the future of educational computing since the university presence has withdrawn. I spoke to the Headteacher about his plans. His intentions for the school were that:-

> "the third and fourth year Juniors... can have a certain amount of time on the keyboard, actually working on Logo, or some pre-produced programs. And with the younger ones, tend to use it as a sort of drill-and-practice type of machine so that children can go and be taught number-bonds, taught tables perhaps." (Li14).

These plans clearly indicate that the school will not solely opt for Logo, even though it is possible to use the computer for Logo throughout the whole age range (as has been observed in a Manchester primary school [Mf(J85)1-4]). At another point the Head said that he planned to use more than just drill-and-practice programs mentioning Logo as one route but also talking about word processing:-

> "I think that this has tremendous possibilities even at primary level, perhaps more so with the less able child... in that they can do a typed piece of work, see it on the screen, we can correct it and discuss it and they will see that piece of work in its final draft and as neat as any work produced by any child, and I think there are a lot of possibilities even for children of all abilities and I'd like to develop this... but of course it was the added expense of having to get a printer for school which would involve a little bit of fund raising. But I think this is another avenue we could take with the computer." (Li9).

He also recognized the data-handling avenue (Li9). His plans were not to neglect Logo altogether: he had wisely recognized problems - some staff apprehension and the difficulties presented to class teachers using Logo without support - but stated that:-

> "I still think that it's something that I will continue in the school... if it's just to teach them to think logically... It's quite different from a reinforcement program in that the children are actually programming - they are creating and I think this is important about Logo. With other programs - the reinforcement type programs... you have very little choice... there's very little freedom for children - they just use the program - it's used just as reinforcement of basics... a certain amount of problem solving, but the Logo was in a position where the children had to think and had to program for themselves." (Li7/8)

These intentions sound hopeful for educational computing at the school: the Head would like to continue with Logo, but is also aware of problems. He knew that the school had been fortunate in having someone to work alongside the staff, as already mentioned, for he admitted that he did not think that the school would have gone very far with Logo without this help. But after the school had had some experience, the Head said he would like to continue the work, at a slower pace, but explore other avenues as well.

The Head also spoke of ideals, if factors like money and time were no object:-

> "....what I'd like is, because there's so much spare capacity in the school - I've got two empty classrooms - I'd love one to be turned into a computer lab with perhaps... a dozen, fifteen computers... why not more... so that a group, a whole chronological group of children can go in and work on the computers." (Li13).

This desire is quite different from that voiced by the Headteacher at Ben Mercy: he considered three to four microcomputers in a primary school of 200-250 pupils was sufficient. But perhaps Longsight's Head's aims should not be seen as excessive since the Logo experience showed that it is quite easy for one microcomputer to be in almost constant use in just one classroom. And besides this, some American schools have opted for the micro-lab plan, as will be discussed in a following section.

Longsight's Headteacher also spoke of what he would like to see in the way of guidance and support. He made the point that he would like staff to attend in-service courses in order to keep up to date with the developments in the field (Li15). He mentioned software evaluation too, saying it was difficult and:-

> "I think there should be some sort of central body who can make some sort of recommendation, perhaps grade the programs, but of course, we all have different standards, and whether this would be successful, I don't know." (Li16).

There is a problem here which has no easy solution. Aside from this, he thought it would be helpful to have some kind of expert who could come into the school and work alongside the teachers. With this help, the computer might become:-

> "a sort of integral part of the classroom where children can go, work on it quietly, undergo some project on it and then return to normal classroom activities while other children go and go on it." (Li18).

But this comment suggests the Headteacher does not see computer education as being an integrated part of the curriculum; rather, it seems something apart from the "normal classroom activities". This attitude is perhaps not too surprising considering that Logo was not integrated into the curriculum.

To sum, the future of computer education at Longsight school is much more promising than that at Headland school. The Headteacher is keen to explore other computer avenues. However, the Logo experience suggests that difficulties may be encountered over integrating the microcomputer into the school curriculum: there is the danger that the computer work will become an isolated aspect of this primary school's activities.

The validity of these predictions about the future of computer education in the three case study schools is, of course, questionable and should only be viewed as spectulative since, as the previous section showed, there are a variety of factors that can effect educational computing. In reality, only time will tell how computer education develops in these schools. However, experience at the schools does at least raise possible routes that might followed.

The next section will consider ways of addressing the barriers to computer education in primary schools and discuss recommendations for the future.

9.3 Addressing The Barriers To Computer Education In Primary Schools.

Even at schools where teachers have become disillusioned with the computer and feel it has fallen short of its promise, a cry is heard for more equipment. Increase in hardware alone is unlikely to solve any problems: with some schools it seems to be the case that they are crying out for more without being sure what they are looking for. Schools need to be ready for more hardware. The deep-seated barriers need to be tackled alongside the problems of a more practical/technical nature. More equipment alone will not be the cure. However, a lot of the blame for the problems with developing computer education is placed on this lack of equipment, but will the picture of educational computing really improve as we head towards "one micro per classroom" (Keeling, 1988, p27)?

The author's experience of well-equipped American schools suggests that this alone will not lead to the more purposeful use of computers in primary education. I spent some time in two Californian schools in April/May 1986 (Case Record, MVf1-29 and LPf1-20). The first school, Monte Vista, is an elementary school with approximately 400 pupils (kindergarten to sixth grade - 11 year olds). The most outstanding feature of this school is its microcomputer laboratory with part-time computer teacher. The micro-lab contained 30 networked Commodore microcomputers, colour monitors, six disk-drives and six printers. Classes were timetabled to the micro-lab although additional work took place on computer set-ups installed in some classrooms. All ages of children used the computer in a variety of ways. Adventure programs (encouraging decision making), Logo, word processing and basic skills reinforcement were the main activities for which the computers were used.

The second school, La Patera, is an elementary school catering for pupils from kindergarten to sixth grade. There are approximately 500 pupils on roll. Like Monte Vista school, La Patera has a microcomputer laboratory and part-time computer teacher. Again, classes were timetabled to the micro-lab which housed 20 Apple microcomputers with colour monitors, disk-drives and nine printers. The school also had microcomputer set-ups on trolleys which could be wheeled into the classrooms. Unlike Monte Vista, the school had a yearly plan of computer activities which the pupils followed: for the first term, all the children learnt word processing (Fr Ed Writer); for the second term, the older ones learnt Logo and the younger and less able ones, "Delta Draw"; for the third term, all the children worked on databases. This plan was not, however, strictly adhered to - other programs were also used, including

"Dazzle Draw", "Print Shop", and drill-and-practice maths tests.

Although it would be unfair to say that these schools were typical, the mere existence of microcomputer laboratories in some Californian primary schools, is indicative of the State's general wealth of equipment, and as a possible future direction for computer education in British schools, these schools are worth considering further.

Apart from this wealth of equipment, other factors made for a potentially fertile computer environment: both the schools, Monte vista and La Patera enjoyed large software libraries, computer "specialists", thoughtful and enthusiastic Headteachers, in-service courses and teachers' aides (paid helpers who carry out routine jobs for teachers). Most of the conditions for the creation of an educational computer environment had seemingly been satisfied. Yet, from observation, Californian computer education was <u>not</u> greatly dissimilar to British. Although a lot of good work with computers was seen to be going on, in view of the Californian schools' wealth of equipment and the other factors, it was not greatly different from the good work that is going on in some British schools with only two or three microcomputers. Indeed, it could also be said that not all the work seen with computers in California was "good": there was little group work as it was normal for pupils to run through programs alone, wearing headphones. If there is a separate room with 30 machines then perhaps there is the temptation to seat each child in front of a machine. It can be said, once again, that hardware alone does not result in educational advancement although, of course, it can resolve some of the essentially practical problems faced by teachers, such as, "where shall we put the micro (in a room/area accessible to all, in the top Junior classroom, on a trolley mobile between classrooms...)?". But before more computers are put into primary schools it needs to be asked what the extra equipment would be used for: would it merely result in more children running through the same old drill-and-practice programs? The most important issue regarding the use of microcomputers in schools is the need for their use to be based on sound educational thinking. Hardware alone does not result in educational advancement.

However, not only did the Californian schools visited have a wealth of equipment, they also had a teacher in charge of educational computing. At both Monte Vista and La Patera there was a part-time teacher who usually worked from 10.30 in the morning to 3 pm (paid by the hour). Typically the micro-teacher went along to the class, or the class came to the lab, with the class teacher and/or aide, for a brief introductory session when the computer work to follow was discussed. The whole session usually lasted about an hour. Both micro-teachers had made attempts to involve and encourage class teachers in computer use but had met with little success. For instance, the micro-teacher at Monte Vista had suggested that the stories the pupils had been writing, using a word processor, and which had been saved on disks, could be taken to the classroom microcomputer and read aloud. However, the teachers had not liked this idea and indeed, the micro-teacher reported that some teachers were really afraid of the computer. It did seem that over reliance on the teacher in charge of computer work was in evidence. Also, the probability of the integration of computer activities, with the rest of the curriculum, was doubtful, mainly because the existence of the micro-lab physically divorced the micro work from other work, despite the efforts made by both micro-teachers to integrate the activities. The computers in classrooms and on trolleys were see as a step in this direction. But on the other hand, it was always the micro-teacher (or the very enthusiastic Headteacher at Monte Vista) who decided what should be done in the computer sessions. On one occasion, the Monte Vista Headteacher was managing the micro-lab session but had to leave half-way through: the class teacher was not at all happy about this; she did not know the program ("Story Book") and felt unable to help the children or answer their questions. The odd comment from teachers was likewise revealing. One teacher at Monte Vista voiced his opinion on Logo: he said that "it's a good program, but can't be used forever". This may indeed be fair comment but he added that his class had "done" Logo. And despite all the school's advantages, like many British teachers, he complained of a lack of time to evaluate software.

These schools had a wealth of equipment and a teacher responsible for microcomputer work, and regular in-service work, and yet still had teachers who were fearful of computers. Teachers regularly had an afternoon off teaching for school-based in-service. The atmosphere on these occasions was informal. The sessions were run by teachers in the locality who had a specialism. The session I observed was taken by two local teachers who demonstrated "good" software, allowing those attending to explore it themselves. I found it surprising that it was assumed that the teachers would be fearful of the computers, despite having had a micro-lab for three years.

The American experience posed more questions about the future of computer education than it answered. Perhaps it is not surprising that micro-labs are unlikely to be the best way ahead for educational computing in primary schools. Greater expectations had rested on the employment of teachers in charge of computer work and the in-service training. More in-service training was a recommendation issued by several of the survey reports examined in Chapter Five. To re-cap, "The Use Of Microcomputers In Primary Schools: Interim Report" (Bleach, P., 1986) ended with the recognition that what is needed is a massive resource injection for in-service training and the provision of information about educational uses of worthwhile software. Likewise, the Welsh Office Report (1984), "Computers In Learning - A Survey Of Computer Provision And Practice In A Selection Of Primary Schools In Wales" identified one of the most pressing needs as in-service training and suitable software. And Jackson, Fletcher and Messer (1986) reported that:-

> "Future needs identified were for better software and greater access to training courses and advisory services." (p53).

Despite observations in Californian schools, it cannot be denied that greater in-service training, of the right sort, will promote the educational use of computers. Perhaps the still fearful American teachers reveal that more than a little in-service work is needed. There is the need for a great deal of in-service work to lift the opinion of many teachers that there is little other than drill-and-practice programs for their microcomputers, and that programs like Logo, databases or word processing, although requiring a certain amount of time and expertise, are more educationally valuable. Ill-founded assumptions and lack of knowledge about the potential of microcomputers to further primary education may only be corrected with in-service work. Ellam and

Wellington (1987) make such a recommendation when discussing how to encourage and foster better microcomputer use. They recommend:-

> "A combination of appropriate and relevant in-service provision, particularly classroom-based Inset." (p45).

This thesis endorses such a recommendation.

Along with in-service provision, the survey reports considered in Chapter Five and reviewed above, also recognize the need for better and more suitable software. Increasingly, this is becoming less of a problem as the amount of quality software grows. One writer, Keeling (1988), usefully recommends that all teachers should be provided with a toolbox of software and documentation. Such a "toolbox" could contain content-free software including a word processor, information retrieval package, Logo, control technology, spreadsheets and adventure simulations. It is not necessary for schools to have a huge software library. Ellam and Wellington (1987) point out:-

> "In relation to software, there is a need for emphasis on quality, not quantity. A small number of high quality programs... would suffice." (p45)

Funds could then be usefully directed to training courses in the use of such "high quality" software rather than in amassing huge software libraries. The more content-free programs are easier to integrate into all areas of the curriculum so that computer education can permeate school work.

The provision of content-free software and increased in-service training should help promote worthwhile computer education in primary schools. Keeling (1988) has the foresight to suggest that it is important to train not only practising teachers in aspects of educational computing but also the new entrants to the profession. He believes that:-

> "When they start teaching they have a role to fulfil in the in-service education of their colleagues. A well-informed probationer can offer a lot to the staff of a school." (p29)

It certainly seems sensible that the new entrants to the teaching profession should have an understanding of the potential of the computer to improve educational practices. Maybe such teachers would later be suitable candidates to take responsibility for the organization of hardware and software. Although (as has already been pointed out and as the American experience endorses), there is a danger of over reliance on a teacher in charge of computers, there are benefits to be gained from such an appointment in a school. If the whole staff's knowledge of computer education has been lifted then the danger of over reliance is lessened. Ellam and Wellington (1987), once again, support such a recommendation. A good teacher in charge of educational computing could help provide opportunities for other teachers to observe successful computer education. Here, the Centre schools development in Gwynedd, could prove useful, although a problem might be freeing teachers to observe "good practice". It would be beneficial too if teachers had non-contact time to work on integrating the computer into their own class work. And to guide such work, it would be helpful if schools developed computer education policies: these would give individual teachers an idea of what they could be doing. But in order to develop such policies many schools would need advice. The Headteacher at Ben Mercy suggested that what is needed is some kind of primary computer liason/adviser person to visit schools and to work on evaluating and distributing "good" software (Bf63). Such a suggestion is also recommended by Ellam and Wellington (1987) who suggest:-

> "Finance and support for the 'roving consultant' (a kind of educational systems analyst) to help to integrate microcomputers into the primary curriculum, to help and advise on classroom management, software selection and evaluation." (p45).

It is clear that many of these recommendations overlap, but in order that the computer improves primary education rather than simply adapts to fit in with what is already in existence, they should be considered by those influencing primary education - at school level, principally the Headteacher, and, at higher levels, those controlling the finances. Perhaps a recent D.E.S. letter setting out national guidelines for information technology (I.T.)in schools holds hope for the future. The central aim is stated as follows:-

> "To harness the potential of I.T. for enhancing the quality of teaching and learning across the curriculum."
> (D.E.S. letter from Thompson, N., to Chief Education Officers, reported in Overlay, Jan 1988, p3).

This sounds promising and additionally, the D.E.S. is aware that information technology:-

> "is still not a part of the teaching repertoire which all teachers fully appreciate or feel comfortable with." (p3)

In order to achieve their aim, they propose high quality software and support materials, funding for extensive in-service training, funding for around 500 advisory teachers, spreading information and advice, and providing for technicians and sufficient hardware. As far as sums of money are concerned, the Educational Support Grant for 1988/9 will provide £10.5 million for advisory teachers (April 1988 apointments) and £8.5 million for hardware.

This is indeed encouraging: there may be hope for computer education in the future. Perhaps attitudes to technology are changing.

In the words of the Ben Mercy Headteacher:-

> "....it's amazing the number of people who have changed their tune, over the last three or four years - some quite real stick-in-the-muds have really changed their minds about... not just computers, but technology in general; you've only got to look at the attitude of this Authority in general... we've caught up actually now." (Bi21/2).

With teachers like this, perhaps Gwynedd will not only catch up but also take a lead in computer education in the primary field.

To further address, or at least illuminate, these barriers to success, more research into the use of microcomputers in primary education is needed. Many teachers have passed thorough the exploratory phase of using computers in schools; further research, exploring the direction computer education is taking, now that the initial choas has subsided, would be useful. And since there is no habitual way of approaching computer education in primary schools, case studies of "good practice" may expand knowledge and guide others.

A number of questions, that could be pursued by research, came to mind through out this study, but they could not be followed up because of the confines of this work. These include:- How will the Gwynedd Centre schools plan develop, and will it be successful in practice? What effect will funding for advisory teachers have, and what will be their role? What in-service training is available? Does attendance on such courses lead to changes in practice? Do in-service courses tackle the problem of correspondence? How can computers be integrated into the primary school curriculum? What thinking goes on behind software development? Will teachers' attitudes/practice be affected or changed by new hardware developments (for example, the Archimedes)? Are home computers used for educational purposes? If they are, what might be the effects? How might computer education help/hinder links across the primary/secondary divide? The list of questions is probably inexhaustible. It would also be of interest to: pursue the reasons behind teacher rejection/acceptance of computers in education; develop the paradigms of computer education (presented in Section 2.3); study Logo further, expecially the question of the development and transfer of problem solving skills; survey schools' policies on computer education and the amount and type of support available (for example, from the M.E.S.U. and L.E.A.).

The computer in primary education is a relatively new area and one which could benefit from further study. Methodology will obviously need to suit the research question. Surveys could be used to establish a broad picture; case studies to reveal the detail, and action research to improve practice.

Having addressed, to some extent, the barriers to computer education in primary schools, the final section of this thesis looks more broadly to the future of microcomputers in primary education and raises certain dangers to be avoided.

9.4 The Future Of Mircocomputers In Primary Education.

The microcomputer in primary eduation is too often met with either evangelical enthusiasm or Ludite rejection. Reactions of this nature can cloud the real issues involved and lead to too few probing questions asked about the educational value of computers.

This thesis presents a rather pessimistic picture of computer education in primary schools, but on the basis of the study undertaken, this picture is a realistic one. Even though this is so, there are, of course, limitations to the research. One of the intentions of this study has been to illuminate the complexities surrounding the use of microcomputers in education, from a number of perspectives (conceptual and practical) and view points (teachers and pupils). Each aspect of the study has its limitations and areas of possible inadequacy have been indicated throughout (from the selection of schools to the naming of the factors in the statistical analysis). Of importance to many reading this work is the extent to which the results are generalizable. There is a problem here, for the main focus of the study has not been on the production of "results", rather, the presentation of "pictures". And as these pictures are unique (and inevitably influenced by the "artist") they are not generalizable to a broader canvas. There are various differing factors in operation in all schools, so it cannot be generalized from this work that, for instance, given the catalogue of software in use at Headland school, all other schools will adopt a similar appraoch to computer education. This has hopefully been made clear in the thesis. Likewise, it would be naive to believe that recommendations about uses of computers could be made for all primary schools. Different schools and different teachers will have different requirements, values and preferences: these should not be ignored, rather, the educational thinking behind them (or lack of it) should be made explicit. Thus, the decision as to the generalizability of this research must lie with the reader and his/her accompanying knowledge of situations, values and beliefs. However, such a statement ought not to render this study worthless, for, it is hoped that at least insights into the complexities of microcomputers in primary education have been gained.

The stance of this thesis is not to doubt a place for microcomputers in schools; rather, it is to be critical of ways in which they are used. Schools do not have to use computers. However, the use of them may be advocated on the grounds that they have the potential to improve educational processes. But to say this is not to deny the reality of experiences such as those at Headland where, although the school uses the computer, improvement to the educational process is not the result. The case study report reveals that a valuable opportunity is often being missed: the potential of the microcomputer to improve educational processes is not being exploited. Perhaps this is no surprise, for, just as more equipment does not result in improvement, simply putting microcomputers into schools in the first place, does not result in change for the better: Papert (1987) comments:-

> "The challenge to school, in its traditional forms, cannot be made by simply dumping computers and computer languages, no matter how well designed, into classrooms. The schools will assimilate the computer to their traditional culture." (p30).

The case study report lends support to this contention. The presence of a microcomputer in a primary school will not of itself make changes. And it is most likely that programs that do not challenge the routine will be implicitly selected, or other programs will be distorted so that they do fit in with what already goes on. Nonetheless, the micro's potential to make changes cannot be denied. Indeed, it has made some improvements to educational processes at some schools (including Ben Mercy). What can be said about the classrooms where the micro has been put to good use? As has already been seen, the teacher is a dominant factor. The future of microcomputers in primary education could be brighter if teachers, firstly, became more informed, and secondly, engaged in critical inquiry and debate into the micro's purpose. Teachers need to be informed of the range of possibilities associated with computers in education. Then, armed with such knowledge, teachers should approach the use of the computer in education, critically. Such a critical approach is essential since computers are not value free instruments; as is clear from the thesis, judgements about the educational validity of computer uses can, and should, be made. But it should also be remembered that at the time of this study, experience in the field was only just emerging; critical awareness was only just developing. The experimental nature of employing computers in schools could perhaps be more widely acknowledged. There is a lack of history and tradition surrounding computer education. Teachers could recognize that, in their dealings with computers, the role of the researcher might usefully be adopted. The teacher adopting this critical researcher role could then work towards understanding computer practice, recognizing situations appropriate for computer practice, and justifying what is done in educational terms. In this way, sound decisions and policies for computer education may be made, so exploiting the computer's potential. If more teachers were to so engage in critical inquiry, the micro might increasingly be used in educationally sound ways, and uses of the micro that do not promote (or those that even distort) education could be avoided. Of course, it is not only in the realm of computers in education that the teacher could adopt the role of critical inquirer. Such an approach can lead to improvements in other areas of practice. It is likely that those who have already adopted such a critical approach to their teaching will also question the purpose of microcomputers in their work. This approach needs to be fostered.

Although teachers are working under demanding circumstances, the purpose of microcomputers in schools must be addressed if future use is to be led by education, rather than technology. The relationship between computers and education is complex and ambiguous and there is a danger that "computer education" will become a contradiction in terms. In other words, if computer use is not developed with the promotion of educational processes in mind, then it will make no sense to call the use of micros in schools, "computer education". The case studies showed that the computer was often not being considered in <u>educational</u> terms; non-correspondence between the use of the micro and the school philosophy was apparent. Teachers were pursuing non-explicitly educational intentions. As has already been suggested, this was excusable in the early days. Now, although computer education in most schools is still at an experimental stage, more teachers must start asking questions about the <u>educational</u> purpose of the programs they use. If they do not, the computer will stand little chance of improving the quality of the educational experiences offered by schools.

The danger that "computer education" will become a contradiction in terms is already present. It can be seen that computers in schools have been influenced by technical and vocational concerns. The first chapter saw that funding for hardware principally came from the D.T.I. rather than the D.E.S.. Computers are in schools now: for schools to remain predominantly educational (rather than training) establishments, the <u>educational</u> purpose of computers must always be at the forefront, and always in question. Beattie (1988) is aware that:-

> "With ever-growing public, industry and government pressure to make micros a feature in the classroom and the curriculum, the likelihood of informed critique declines." (p181)

The pressure for use of computers in schools could come from educational quarters. Educationalists could become more vocal in the arena. If this does not happen then the opportunities computers afford for educational improvement will be snatched away in the fist of the "new vocationalism". More seriously, computers could be utilized in the destruction of educational values.

The danger is that in this "cost-effective" society, the purpose of the computer might be distorted to some vocational/technical end. The school's function is not simply to offer pupils a catalogue of "skills" from which to choose. Were that its function, the school would be quite correct in seeing the student as a sort of market basket (Weizenbaum, 1976). The mere teaching of skills is not enough. Computer education is not only about equipping pupils with marketable, vocational skills. Again, if interpreted in this sense, the term, "computer education" becomes self-contradictory. Computer education must concern something in addition to the acquisition of skills (however useful). Educational computing, perforce, needs to be about promoting worthwhile educational processes. Teachers who use the computer in primary schools should not perhaps be planning to equip their pupils with some marketable skill, for this is not computer education, this is some form of vocational training. Schools need to withstand the ever increasing pressure to become explicitly vocational. To save computer education from the pressures of the new vocationalism, teachers need to become critical, educational inquirers. If they do not, at best, micros may be absorbed into the status quo; at worst, "computer education" may become divorced from educational concerns, and therefore, a contradiction in terms. Should this happen, and go unrecognized, or unchallenged, educational values and practices could be significantly undermined.

A criticism of this thesis might be that it raises many probing questions, but seemingly avoids "answers". In defence, it should also be clear that there are no easy "answers", that computers in schools cannot be divorced from judgements of value, and that the complexities and ambiguities cannot be escaped. At the very least, this thesis has drawn attention to the relationship between computers and education. And, although the overall picture of computer education presented by the case studies is rather pessimistic, at least it has tried to be drawn from a true and realistic prespective. The real state of computer education in schools needs to be confronted: only then may real improvements be made. Schools need to develop their experiences, and then reflect, critically. In this way a critical awareness can develop, and the computer may then be used to improve the real quality of the educational processes offered by primary schools.

BIBLIOGRAPHY.

* indicates text that has not been directly referred to, but has, nonetheless, informed this thesis.

ADELMAN, C., JENKINS, D. & KEMMIS, S. (1976), "Re-thinking Case Study: Notes Taken From The Second Cambridge Conference", Cambridge Journal Of Education Vol.6 No.3. pp139-150.

---

*ANDERSON, B. (1986), Learning With Logo: Some Classroom Experiences. M.E.P.

---

*ARCHAMBAULT, R. D. ed (1965), Philosophical Analysis And Education. Routledge And Kegan Paul, London.

ATKINSON, P. & DELAMONT, S. (1981), "Bread And Dreams Or Bread And Circuses? A Critique Of 'Case Study' Research In Education", in SHIPMAN, M. ed, (1981), Educational Research: Principles, Policies And Practices. Longmans, London.

---

*BAKER, C. (1984), "A Critical Examination Of The Effect Of The Microcomputer On The Curriculum", in TERRY, C. (1984), Using Microcomputers In Schools. Croom Helm, Beckenham.

---

*BANTOCK, G .H. (1980), Dilemmas Of The Curriculum. Martin Robertson, Oxford.

BEATTIE, C. (1988), "Studying, Taming And Exploiting The Micro", Journal Of Curriculum Studies, Vol.20 No.2. pp181-188.

---

*BELL, J. (1987), Doing Your Research Project: A Guide For First-Time Researchers In Education And Social Science. Open University Press, Milton Keynes.

BLEACH, P. (1986), The Use Of Microcomputers In Primary Schools: Interim Report. School of Education, University Of Reading.

---

*BORK, A. (1981), Learning With Computers. Digital Press, Bedford, Masschussets.

---

*BORK, A. (1985), Personal Computers For Education. Harper & Row, New York.

---

*BROWN, I. (1984), "Looking For Quality In Software: Guidelines For Selection And Evaluation", Educational Computing Jan. 1984. p34.

BURGESS, H. (1985), "Case Study And Curriculum Research" in BURGESS, R. G. ed (1985), Issues In Educational Research: Qualitative Methods. Falmer Press, Lewes, Sussex.

BURGESS, R. G. ed (1984), The Research Process In Educational Settings: 10 Case Studies. Falmer Press, Lewes, Sussex.

*BURGESS, R. G. ed (1985), Strategies Of Educational Research: Qualitative Methods. Falmer Press, Lewes, Sussex .

CATTELL, R. B. (1966), "The Scree Test For The Number Of Factors", Multivariate Behavioural Research, Vol.1 pp245-276.

*CHEN, M. & PAISLEY, W. eds (1985), Children And Microcomputers: Research On The Newest Medium. Sage, Beverley Hills.

CHILD, D. (1970), The Essentials Of Factor Analysis. Holt, Rinehart & Winston, London.

*CLEMENTS, D. H. & GULLO, D. F. (1984), "Effects Of Computer Programming On Young Children's Cognition", Journal Of Educational Psychology, Vol.76 No.6. pp1051-1058.

*COCKCROFT W. H., et al (1982), Mathematics Counts. H.M.S.O., London.

COHEN, B. (1969), Educational Thought: An Introduction. Macmillan, London.

COHEN, B. (1983), Means And Ends In Education. George Allen & Unwin, London.

COHEN, L. & MANION, L. (1980), Research Methods In Education. Croom Helm, London.

*COLLIS, B. (1984), "Implications Of The Educational Use Of Computers In North American Elementary Schools", British Journal Of Educational Studies, Vol.32 No.2. pp125-133.

*COWAN, J. (1985), "Effectiveness And Efficiency In Higher Education", Higher Education Vol.14. pp235-239.

CUFFARO, H. K. (1984), "Microcomputers In Education: Why Is Earlier Better?" in SLOAN, D. ed (1984), The Computer In Education: A Critical Perspective. Teachers College Press, New York.

*DAINES, D. ed (1983), MicroPrimer: A Foundation For Teachers. C.E.T./M.E.P.

DAVENEY, T. F. (1973) "Education - A Moral Concept" in LANGFORD, G. & O'CONNOR, D. J. eds (1973), New Essays In The Philosophy Of Education. Routledge And Kegan Paul.

*DAVIS, A. (1987), "Using Databases", Junior Education, Jan. 1987. ppvi-vii.

*DAVY, J. (1984), "Mindstorms In The Lamplight" in SLOAN, D. ed (1984), The Computer In Education: A Critical Perspective. Teachers College Press, New York.

---

*DeCORTE, E. & VERSCHAFFEL, L. (1985?), Effects Of Computer Education On Children's Thinking Skills. Unpublished Paper.

---

*DERTOUZOS, M. L. & MOSES, J. eds (1980), The Computer Age: A Twenty-Year View. M.I.T. Press, Cambridge, Masschusetts.

---

*DOCKRELL, W. B. & HAMILTON, D. eds (1980), Rethinking Educational Research. Hodder & Stoughton, London.

DREYFUS, H. L. & DREYFUS, S. E. (1984), "Putting Computers In Their Proper Place: Analysis Versus Intuition In The Classroom", Teachers College Record, Vol.85, No.4. pp578-601.

---

*EATON, S. & OLSON, J. (1986), "'Doing Computers?' The Micro In The Elementary Curriculum", Journal Of Curriculum Studies, Vol.18 No.3. pp342-344.

---

*EISNER, E. W. (1985), The Art Of Education Evaluation: A Personal View. Falmer Press, Lewes, Sussex.

ELLAM, N. & WELLINGTON, J. (1986/7), Computers In The Primary Curriculum, University Of Sheffield Division Of Education, Papers In Education.

ELLAM, N. & WELLINGTON, J. (1987), "It's The Chickens, You See...", T.E.S. 16/10/87. pp44-45.

ELLIOTT, J. (1976), "Developing Hypotheses About Classrooms From Teachers' Practical Constructs", Interchange, Vol.7 No.2. pp2-20.

ENTWISTLE, N. J. (1973), Methods Of Educational Enquiry, Block 1, E341. Open University, Milton Keynes.

---

*ESTERSON, D. (1985), "The Management Of Computing Resources In Schools", Journal Of Computer Assisted Learning, Vol.1. pp134-138.

---

*EVERTON, T. & DUNN, S. (1985), "An Investigation With Turtle Geometry", Micromath Vol.1 No.1. pp26-27.

---

*EYRE, R. (1983), "Viewpoint: The Liberation Of Education", Educational Computing, Oct. 1983. pp4-5.

---

*EYRE, R. (1984), "Viewpoint: A New Approach To The School Curriculum", Educational Computing, Feb. 1984. pp4-5.

---

*EYRE, R. (1987), "Learning To Live With Logo; Some Teacher Experiences", Report Of Teachers' Experiences Of A 20 Day Logo Course. College of St. Paul & St. Mary, Cheltenham.

*FIDDY, P. (1983), "Viewpoint: Learning, Teaching, Instructing: Settling The Difference", Educational Computing, April 1983. p5.

*FINLAYSON, H. (1983), "Simple Logo In Primary Schools: A Structured Or Unstructured Approach?", MicroScope Logo 'Special'. pp10-12.

FINZE, B. & RESEK, D. (1984), "Computer Languages And Learning" in TERRY, C. ed (1984), Using Microcomputers In School. Croom Helm, Beckenham.

*FLETCHER, T. J. (1983), Microcomputers And Mathematics In Schools. A Discussion Paper. D.E.S., London.

FOTHERGILL, R. (1982), "The Forward", in SMITH, C. ed (1982), Microcomputers In Education. Ellis Horwood, Chichester.

FRANKENA, (1973), "The Concept Of Education Today" in DOYLE, J. F. ed (1973), Educational Judgements. Routledge And Kegan Paul, London.

*GANDERTON, P. R. (1985), "Investigations: The Process Of Opening The Doors To Mathematics", Mathematics In School May 1985. pp12-14.

GARLAND, R. ed (1982), Microcomputers And Children In The Primary School. Falmer Press, Lewes, Sussex.

GARLAND, R. (1983), "Primary Considerations" in DAINES, D. ed (1983). MicroPrimer: A Foundation For Teachers. M.E.P./C.E.T.

*GEFFEN, M. (1984), "Technology, Educational Technonolgy, Independent Learning And Autonomy" in HARBER, MEIGHAN & ROBERTS eds (1984), Alternative Educational Futures. Holt, London.

*GIBBONS, L. (1986), "Escape Or Run", Journal Of Computer Assisted Learning, Vol.2 No.1. pp22-27.

GOLBY, M (1982) "Microcomputers And The Primary Curriculum" in GARLAND, R. ed (1982), Microcomputers And Children In The Primary School. Falmer Press, Lewes, Sussex.

GOLBY, M., GREENWALD, J. & WEST, R. eds (1975), Curriculum Design. Croom Helm, London.

GOLDSTEIN, R. (1986), "Mathematics After Logo", Maths Teaching (MT115). pp14-15.

*GOODYEAR, P. (1985), "Computer-Assisted-Learning, Computer-Based-Guidance And The Teaching Of Educational Research Methods", British Educational Research Journal, Vol.11 No.3. pp291-299.

*GOODYEAR, P. (1987), "Sources Of Difficulty In Assessing The Cognitive Effects Of Learning To Program", Journal Of Computer Assisted Learning, Vol.3 No.4. pp214-223.

*GORDON, P. ed (1981), The Study Of The Curriculum. Batsford, London.

GWYNEDD EDUCATION AUTHORITY (1986), The Primary School Curriculum: Draft. Unpublished document. County Offices, Caernarfon.

HAMILTON, D. (1976), Curriculum Evaluation. Open Books, London.

*HAMMOND, R. (1984), Forward 100. Viking Publishers, London.

HARNETT, A. & NAISH, M. (1976), Theory And The Practice Of Education. Volume 1. Heinemann Educational Books, London.

*HARPER, D. O. & STEWART, J. H. (1983), RUN: Computer Education. Brecks/Cole, Monterey.

*HARRIS, A. (1970), Thinking About Education. Heinemann Educational, London.

*HARTLEY, J. R. (1984), "Some Psychological Aspects Of Computer Assisted Learning And Teaching", P.L.E.T., Psychological Issues, Vol.22 No.2. pp140-149.

HARVEY T. J. & WILSON, B. (1985), "Gender Differences In Attitudes Towards Microcomputers Shown By Primary And Secondary School Pupils", British Journal Of Educational Technology Vol.6 No.3. pp183-187.

*HAWKRIDGE, D. (1983), New Information Technology In Education. Croom Helm, London.

HAYDON, R. J. (1984), "Primary Education And Computers" in Humberside And Yorkshire Maths Council, Impressions 2: Micros In The Primary School.

*HEYWOOD, G. (1985), "Computer-Assisted-Learning As Innovation In The Primary School", Research In Education, No.33. pp41-47.

HIRST, P. H. (1965), "Liberal Education And The Nature Of Knowledge", in ARCHAMBAULT, R. D. ed. (1965), Philosophical Analysis And Education. Routledge And Kegan Paul, London.

HIRST, P. H. & PETERS, R. S. (1970), The Logic Of Education. Routledge And Kegan Paul, London.

*HODGES, M. (1984), "Topic Work: The Role Of The Micro", M.U.S.E. Report No.5. pp16-22.

HOLLY, M. L. (1984), Keeping A Personal - Professional Journal. Deakin University.

HOLT, M. (1981), Evaluating The Evaluators. Hodder & Stoughton, London.

HOLT, M. (1985), "Hard Facts About Soft Money" (book review), Journal Of Curriculum Studies, Vol.17 No.3. pp360-362.

HOUSE, E. (1980), "The Major Approaches" in ESC801 Curriculum Evaluation, Unit 2: History And Approaches, (1982), Deakin University.

HOWE, J. & Du BOULAY, B. (1979), "Microprocessor Assisted Learning:Turning The Clock Back?", P.L.E.T. Vol.16 No.3. pp240-245.

*HOWE, J. A. M. & Du BOULAY, B. (1979), "Re-learning Mathematics Through Logo: Second Progress Report", Working Paper No. 63. D.A.I., University of Edinburgh.

*HOWE, J. A. M., Du BOULAY, B. & JOHNSON, K. (1982), "Re-learning Mathematics Through Logo", Research Paper No. 178. D.A.I., University of Edinburgh.

HOYLE, E. (1983), "Computers And Education: A Solution In Search Of A Problem" in MEGARRY, J., WALKER, D. R. F., NISBET, S. & HOYLE, E. eds, World Yearbook Of Education: Computers And Education 1982/3. Kogan Page, London.

*HOYLES, C. & SUTHERLAND, R. (1985) "Open Minds", T.E.S. 25/10/85. p39.

HOYLES, C., SUTHERLAND, R. & EVANS, J. A Preliminary Investigation Of The Pupil-Centred Approach To The Learning Of Logo In The Secondary School Mathematics Classroom. 1983 - 1984. Logo Maths Project, University Of London.

*HUBBARD, G. (1984), "Social And Educational Effects Of Technological Change", British Journal Of Educational Studies Vol.32, No.2. pp108-117.

*HUBBARD, G. (1986), "Organizing For Innovation: A Comparative Commentary On Two Government Programmes", Journal Of Computer Assisted Learning, Vol.2 No.1. pp3-7.

HUGHES, M., MACLEOD, H. & POTTS, C. (1984), "Logo: A New Direction In Infant Maths", T.E.S. 05/10/84. p43.

*HUGHES, M., MACLEOD, H. & POTTS, C. (1984), "Mind Storms", T.E.S., 09/11/84. p49.

*HULL, C. (1985), "Between The Lines: The Analysis Of Interview Data As An Exact Art", British Journal Of Educational Research, Vol.11 No.1. pp27-31.

INDEPENDENT SCHOOLS MICROELECTRONICS CENTRE (1985), A Draft Policy Statement On The Place Of Computers And Information Technology In Schools. Westminster College, Oxford.

JACKSON, A., FLETCHER, B. & MESSER, D. J. (1986), "A Survey Of Microcomputer Use And Provision In Primary Schools", Journal Of Computer Assisted Learning Vol.2 No.1. pp44-55.

JONES, A. & SCRIMSHAW, P (1988), Computers In Education 5-13. Open University Press, Milton Keynes.

JONES, J. (1980), Microcomputers And Their Use In Primary Schools. C.E.T., London.

JONES, R. (1982), "Directions", Micro-Scope 5, March 1982. p5.6.

KEELING, R. (1988) "A Trainers's Eye View", Educational Computing, Jan. 1988. pp27-29.

*KELLY, A .V. (1982), The Curriculum: Theory And Practice, 2nd Edition. Harper & Row, London.

KELLY, A. V. (1984), Microcomputers And The Curriculum. Harper & Row, London.

KELLY, A. V. (1986), Knowledge And Curriculum Planning. Harper & Row, London.

KENNY & GROTELUESCHEN, (1984), "Making The Case For Case Study", Journal Of Curriculum Studies Vol.16 No.1. pp37-51.

KEMMIS, S., ATKIN, R. & WRIGHT, E. (1977), "How Do Students Learn?" in Working Papers On Computer Assisted Learning, U.N.C.A.L. Evaluation Studies. C.A.R.E. Occasional Publications No.5, U.E.A., Norwich.

KEMMIS, S., COLE, P. & SUGGETT, D. (1983), Towards The Socially Critical School. Victoria Institute Of Secondary Education.

KIM, JAE-ON (1975), "Factor Analysis" in NIE, N. H., HULL, C. H., JENKINS, J. G., STEINBRENNER, K. & BENT, D. H. eds S.P.S.S. Second Edition. McGraw-Hill, London.

*KINGSNORTH, R. (1986), "Microworlds", Maths Teaching (MT115). pp46.

*KLEINIG, J. (1982), Philosophical Issues In Education. Croom Helm, London.

KULN, T (1970), The Structure Of Scientific Revolutions. University of Chicago Press, Chicago.

*LANGFORD, G. (1968), Philosophy And Education. Macmillan, London.

*LAWLER, R. W. (1985), Computer Experience And Cognitive Development: A Child's Learning In A Computer Culture. Ellis Horwood, Chichester.

LAWTON, D. (1980), The Politics Of The School Curriculum. Routledge And Kegan Paul, London.

*LEE, V. & ZELDIN, D. eds (1982), Planning In The Curriculum, Hodder & Stoughton And Open University, Sevenoaks.

*LEES, P. (1986), "How Are Computers To Be Used In Our Schools?", Programmed Learning And Educational Technology (PLET), Vol.23, No.2. pp111-115.

*LERON, U. (1985), "State Transparency", Micromath, Vol.1 No.2. pp37-41

*LESGOLD, A. & REIF, F. (1983), "Computers In Education: Realising The Potential", Chairmen's Report Of A Research Conference, Pittsburgh, Pennsylvania, Nov 22-24, 1982. June 1983: Summary Report. August 1983: Full Report.

LEWIS, B. (1982), "Mechanism For C.A.L. Origination" in SMITH, C. ed (1982) Microcomputers In Education. Ellis Horwood, Chichester.

LOCKHEAD & CLEMENTS eds (1979), Cognitive Process Instruction: Research On Teaching Thinking Skill. New York.

*MACDONALD, B., JENKINS, D., KEMMIS, S. & TAWNEY, D. (1975), The Programme At Two: An U.N.C.A.L. Companion To Two Years On. U.E.A., Norwich.

*MARTIN, A. (1983), "The Spirit Of Logo Discerned", MicroScope Logo 'Special'. pp2-6.

*MAUDE, R. (1984), "Viewpoint: Simulation - A Natural Way Of Learning", Educational Computing, Jun. 1984. p4.

McGEE, P. (1984), "Coherence Is The Casulty", T.E.S., 09/11/84 p53.

MEGARRY, J. (1983), "Thinking, Learning And Educating: The Role Of The Computer" in MEGARRY, J., WALKER, D. R. F., NISBET, S. & HOYLE, E. eds World Yearbook Of Education 1982/3: Computers And Education. Kogon Page, London.

*MICHAYLUK, J. O. (1986), "Logo: More Than A Decade Later", British Journal Of Educational Technology, Vol.17 No.1. pp35-41.

MICROELECTRONICS EDUCATION PROGRAMME (M.E.P.) (1984), Computers In The Primary School. Conference Report, Winchester.

MICROELECTRONICS EDUCATION PROGRAMME (M.E.P.) (1984), Information Leaflet.

*MICROELECTRONICS EDUCATION PROGRAMME (M.E.P.) (1985), A Teacher Training Pack: Posing And Solving Problems With Logo.

*MILLER, L. (1986), "Computers And The Language Arts: Theory And Practice", Journal Of Curriculum Studies, Vol.18 No.3. pp285-297.

*MOORE, J. L. (1985), "Development Of A Questionnaire To Measure Secondary School Pupils' Attitudes To Computers And Robots", Journal Of Educational Studies, Vol.11 No.1. pp33-40.

MOORE, T. W. (1974), Educational Theory: An Introduction. Routledge And Kegan Paul, London.

*MULLAN, T. (1982), "Some Observations On Children's Attitudes To, And The Role Of, Microcomputers In Primary Schools", in GARLAND, R. ed (1982), Microcomputers And Children In The Primary School. Falmer Press, Lewes, Sussex.

*MULLAN, T. (1982), "Welcome To Logo", Educational Computing, Sept. 1982. pp36-37.

*MULLAN, T. (1983), "St.Maurice School Logo Project: A Rationale", MicroScope, Logo 'Special'. pp15-19.

*MULLAN, T. (1983), Software - An Evolutionary Model", MicroScope 8. pp3-5.

*MULLAN, A. P. (1984), Children And Computers In The Classroom. Castle House Publications, Kent.

*NAISH, M. (1984), "Education And Essential Contestability Revisited", Journal Of Philosophy Of Education, Vol.18, No.2. pp141-153.

*NASH, A. & BALL, D. (1982), An Introduction To Microcomputers In Teaching. Hutchinson, London.

*NASH, A. & BALL, D. (1983), "Viewpoint: Microcomputers - Are They For You?", Educational Computing, Feb. 1983. pp4-5.

NEILL, A. S. (1962), Summerhill. Pelican, (1968), Middlesex.

*NICOLSON, R. I., & SCOTT, P. J. (1986), "Computer And Education: The Software Production Problem", British Journal Of Educational Technology Vol.17 No.1. pp26-35.

NISBET, J. & WATT, J. (1978/9), Rediguide 26: Case Study. TRC Rediguides Ltd., University Of Nottingham.

*NOSS, R. (1983), "Learning With Logo: Is The Teacher Necessary?" Paper presented at B.L.U.G. conference, Sept. 1983. Advisory Unit For Computer Education, Hatfield.

*NOSS, R. (1983), "Approaching Logo", MicroScope Logo 'Special'. pp13-15.

NOSS, R. (1984), "Children Learning Logo Programming", The Chiltern Logo Project, Interim Report No.2. M.E.P. Advisory Unit for Computer Education, Hatfield.

*NOSS, R. (1986), "Is Small Really Beautiful?", Micromath Vol.2 No.1. pp26-29.

O'CONNOR, D. J. (1957), An Introduction To The Philosophy Of Education. Routledge And Kegan Paul, London.

O'HEAR, A. (1981), Education, Society And Human Nature: An Introduction To The Philosophy Of Education. Routledge And Kegan Paul, London.

OPPENHEIM, A. N. (1966), Questionnaire Design And Attitude Measurement. Heinemann, London.

*O'SHEA, T. & SELF, J. (1983), Learning And Teaching With Computers: Artifical Intelligence In Education. Harvester Press, Brighton.

*OXFORD ENGLISH DICTIONARY (Pocket) (1952 reprint), The Claredon Press, Oxford.

PAPERT, S. (1980), Mindstorms: Children, Computers And Powerful Ideas. Harvester Press, Brighton.

*PAPERT, S. (1980), "Computers And Learning" in DERTOUZOS, M. L. & MOSES, J. eds (1980), The Computer Age: A Twenty-Year View. M.I.T. Press, Cambridge, Masschusetts.

*PAPERT, S. (1987), "Computer Criticism Vs. Technocentric Thinking", Information Technology And Education, Vol.16. pp27-34.

PARLETT, M. & HAMILTON, D. (1976), "Evaluation As Illumination" in ERM881 Case Study Methods, Unit 2, (1983), Deakin University. (Alternative source, TAWNEY, D. A. ed (1976), Curriculum Evaluation Today: Trends And Impressions. Macmillan, London).

*PARRY, M. T. (1985), "Trying Times With A Turtle", Journal Of Computer Assisted Learning, Vol.1. pp81-86.

*PEA, R. D., KURLAND, D. M. & HAWKINS, J. (1985), "Logo And The Development Of Thinking Skills" in CHEN, M. & PAISLEY, W. eds (1985), Children And Microcomputers: Research On The Newest Medium. Sage, Beverley Hills.

PEAKE, G. M. (1984), "An Alien Invader" in Humberside & Yorkshire Maths Council, Impressions 2: Micros In The Primary School.

*PEARSON, S. (1986), Primary Education: The Role Of The Microcomputer. M.E.U. Cymru.

PETERS, R. S. (1959), Authority, Responsibility And Education. George Allen & Unwin Ltd, London.

*PETERS, R. S. (1966), Ethics And Education. George Allen & Unwin Ltd., London.

PETERS, R. S. ed (1967), The Concept Of Education. Routledge And Kegan Paul, London.

PETERS, R. S. (1977), Education And The Education Of Teachers. Routledge And Kegan Paul, London.

*PHILLIPS, R. J. (1986), "MicroPrimer Maths: There's More Than Meets The Eye", Mathematics In School, March 1986. pp29-32.

*POLYA, G. (1957), How To Solve It: A New Aspect Of Mathematical Method. Prince Town University Press, New York.

*POPE, M. & DENICOLO, P. (1986), "Intuitive Theories - A Researhcer's Dilemma: Some Practical Methodological Implication", British Educational Research Journal Vol.12 No.2. pp153-166.

*PRICE, N. (1985), "Primary Mathematics: Is The Computer In Control", Micromath, Vol.1 No.2. pp11-12

REID, M. (1981), "The Deliberate Approach To The Study Of The Curriculum And Its Relation To Critical Pluralism" in ESC801 Curriculum Evaluation, Unit 1: An Overview, (1982), Deakin University. (p12)

RHEINGOLD, (1983), "Video Games Go To School", Psychology Today Vol.17 No.9.

*RICHARDSON, T. (1986), "Using Micros To Encourage Pupil Autonomy", Education 3 - 13, Vol.14, No.1. pp42-54

*RICHMOND, W. K. (1965), Teachers And Machines: An Introduction To The Theory And Practice Of Programmed Learning. Collins, London.

ROBERTS, A. & EWAN, R. T. A. (1984), "A Case Study Of Educational Microcomputer Use In Upper Schools", Research In Education No.32. pp67-85.

*ROSS, A. (1987), "Empty Programs Make Most Sense", Junior Education, Jan 1987. pp26-27.

*ROSS, P. (1983), Logo Programming. Addison-Wesley, London.

*ROWE, C. (1986), People And Chips: The Human Implications Of Information Technology. Paradigm Publishing, London.

*ROWLAND, S. (1984), The Enquiring Classroom: An Introduction To Children's Learning. Falmer Press, Lewes, Sussex.

*RUSHBY, N. (1979), An Introduction To Educational Computing. Croom Helm, London.

RUSHBY, N. (1984), "Styles Of Computer Based Learning" in TERRY, C. ed (1984), Using Microcomputers In Schools. Croom Helm, Beckenham.

RUSHBY, N. (1985), "Who Calls The Tune?" Times Higher Educational Supplement 28/06/85. p27.

RUTHVEN, K. (1984), "Computer Literacy And The Curriculum", British Journal Of Educational Studies, Vol.32 No.2. pp134-147.

*SAGE, M. & SMITH, D. J. (1983), Microcomputers In Education: A Framework For Research. S.S.R.C., London.

*SAGE, M. & SMITH, D. (1984), "Teachers, Trainers, And Computer-Based Education", E.S.R.C. Newsletter 52. pp21-23.

*SCHENK, C. (1984), "Micros And Language", M.U.S.E. Report No.5. pp3-6.

*SEIDEL, R., ANDERSON, R. & HUNTER, B. (1982), Computer Literacy. Academic Press, New York.

*SELF, J. (1985), Microcomputers In Education: A Critical Evaluation Of Educational Software. Harvester Press, Brighton, Sussex.

SHEARD, J. A. (1982), "C.A.L. In The Classroom", Micro-Scope 5, March 1982. pp5.35.

SHEINGOLD, K., KANE, J. H. & ENDREWEIT, M. (1983), "Microcomputer Use In Schools: Developing A Research Agenda", Harvard Educational Review, Vol.53 No.4, pp412-432.

SHIPMAN, M. D. (1973 - 2nd edition, 1981), The Limitations Of Social Research. Longmans, Harlow.

SIANN, G. & MACLEOD. H (1986), "Computers And Children Of Primary School Age: Issues And Questions", British Journal Of Educational Technology, Vol.17 No.2. pp133-144.

SKILBECK, M. (1976), E203: Curriculum Design And Development: Unit 2: "Basic Questions In Curriculum". Open University, Milton Keynes.

*SLOAN, D. ed (1984), The Computer In Education: A Critical Perspective. Teachers College Press, New York.

*SMITH, C. ed (1982) Microcomputers In Education. Ellis Horwood, Chichester.

*SMITH, D. & KEEP, R. (1986) "Children's Opinions Of Educational Software", Educational Research, Vol.28 No.2. pp83-88.

*SMITH, P. R. (1986), Advances In Computer-Assisted Learning (Selected Papers From The C.A.L. '85 Symposium). Pergamon Press, Oxford.

*SNELDERS, P. (1981), "An Essentially Contesting Philosopher: A Reply To John Wilson", Journal Of Philosophy Of Education, Vol.15 No.1. pp17-22.

STAKE, R. (1981), "Persuasions, Not Models" in ESC801 Curriculum Evaluation, Unit 3: Philosophical And Procedural Dilemmas, (1982), Deakin University. (p5/6).

STENHOUSE, L. (1975), An Introduction To Curriculum Research And Development. Heinemann, London.

STENHOUSE, L. (1978), "Towards A Contemporary History Of Education" British Journal Of Educational Research Vol.4 No.2. pp21-39.

*STENHOUSE, L. (1983), "Case Study In Educational Research And Evaluation" in ERM881 Case Study Methods Unit 1: Case Study: An Overview. (1983) Deakin University.

*STEWART, J. "Micros And Primary Science", M.U.S.E. Report No.5. pp11-15.

*STRAKER, A. (1986), "A Sorry State Of Affairs", T.E.S. 09/05/86. p30.

*STRAKER, A. & BLYTHE, K. (1986), "Diverse Uses", T.E.S., 16/05/86. p54.

*STRAUGHAN, R. & WILSON, J. (1983) Philosophizing About Education. Holt, Rinehart & Winston, London.

TAYLOR, R. P. ed. (1980), The Computer In The School: Tutor, Tool, Tutee. Teachers College Press, Columbia, New York.

TERRY, C. ed (1984), Using Microcomputers In Schools. Croom Helm, Beckenham.

THOMPSON, N. (D.E.S.), letter to Chief Education Officers, reported in Overlay, Jan. 1988. p.3.

*THORNE, M. (1985), "Forward Logo?", T.E.S. 25/10/85. p38

*TRIPP, D. H. (1985), "Case Study Generalisation: An Agenda For Action", British Educational Research Journal, Vol.11 No.1. pp33-43.

VERNON, P. E. & MILLER, K. M. (1976), Graded Arithmetic-Mathematics Test (Junior) Metric Edition. Hodder & Stoughton, Kent.

WALKER, R. (1974), "The Conduct Of Educational Case Study: Ethics, Theory And Procedures" in ERM881 Case Study Methods, Unit 2, (1983). Deakin University. (Original source: MACDONALD, B. WALKER, R. (1974), Innovation, Evaluation, Research And The Problem Of Control; Some Interim Papers, Ford SAFARI Project).

*WALKER, R. (1985), Doing Research. Methuen Co. Ltd, London.

*WATT, D. H. (1979), "A Comparison Of The Problem Solving Styles Of Two Students Learning. Logo: A Computer Language For Children" in Creative Computing, Dec 1979. pp86-90.

WATT, D. H. (1982), "Education For Citizenship In A Computer-Based Society", in SEIDEL, R., ANDERSON, R. & HUNTER, B. (1982), Computer Literacy. Academic Press, New York.

*WEBB, N. M. (1984), "Microcmputer Learning In Small Groups: Cognitive Requirements And Group Processes", Journal Of Educational Psychology Vol.76 No.6. pp1076-1087.

WEIZENBAUM, J. (1976), Computer Power And Human Reason. W. H. Freeman & Co, San Fransisco.

WEIZENBAUM, J. (1980), "Once More: The Computer Revolution" in DERTOUZOS, M. L. & MOSES, J. eds (1980), The Computer Age: A Twenty-Year View. M.I.T. Press, Cambridge, Masschusetts.

*WELLINGTON, J. (1985), "Testing Turtle", T.E.S. 21/06/85. pp51-52.

*WELLINGTON, J. (1985), Children Computers And The Curriculum. Harper &-Row, London.

*WELLINGTON, J. (1986), "Proving 'In-House' Teaching Experience: A Case Study Of Its Values And Possibilities", Journal Of Education For Teaching Vol.12 No.1. pp47-51.

WELSH OFFICE, (H.M.I) (1984), Computers In Learning - A Survey Of Current Provision And Practice In A Selection Of Primary Schools In Wales.

WELSH OFFICE, (1986), "Survey Of Microcomputers In Schools", Welsh Education Statistics Bulletin No.3. H.M.S.O.

WESTON, P. (1985), "Computer Based Learning In Clwyd". Unpublished.

WILKINSON, A. C. (1983), Classroom Computers And Cognitive Science. Academic Press, New York.

WILLIS, (1981), "A Reconceptualist Perspective On Curriculum Evaluation" in ESC801 Curriculum Evaluation, Unit 1: An Overview, (1982). Deakin University.

WILSON, J. (1977), Philosophy And Practical Education. Routledge And Kegan Paul, London.

WILSON, J. (1981), "Concepts, Contestability And The Philosophy Of Education." Journal Of Philosophy Of Education, Vol.15 No.1. pp3-16.

*WILSON, S. (1977), "The Use Of Ethnographic Techniques In Educational Research", Review Of Educational Research, Vol.47 No.1. pp245-265.

WHITE, J. P. (1971), "The Concept Of Curriculum Evaluation" in GOLBY, M., GREENWALD, J. & WEST, R., eds (1975) Curriculum Design. Croom Helm, London.

WOODS, B. (1983), "Computers In Education" in DAINES, D. ed (1983), MicroPrimer: A Foundation For Teachers. M.E.P./C.E.T.

WOODS, R. G. & BARROW, R. St. C. (1975), An Introduction To The Philosophy Of Education. Methuen & Co. Ltd, London.

*YIN, R. K. (1984) Case Study Research: Design And Methods. Sage Publications, Beverley Hills.