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A MASTERS THESIS

COMPUTER ASSISTED LEARNING IN SCHOOL GEOGRAPHY


by

PAUL J H HEINRICH

A Masters Thesis submitted for the award of Master of Philosophy of the Loughborough University of Technology

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ABSTRACT

Although there have been strenuous attempts since the early 1980's to develop the use of information technology in schools in England and Wales these have been only partially successful. This study investigates and evaluates the development of CAL in geographical education, from its beginnings to the present day. It presents an overview of the development of the medium in Britain and elsewhere together with an analysis of the various forms of CAL and their relationship to effective learning. The research design is discussed, together with the authors own interests and experiences in the area. Data was obtained through questionnaire surveys of LEA's and a small but representative sample of Geography Departments in a variety of schools. The research findings are presented in two parts. The first considers the present extent of CAL usage in schools and further, identifies the software most commonly available together with the topic areas for which CAL is used. The second part discusses the problems of the evaluation of this software and on the basis of teacher evaluation of selected programs attempts to define those elements inherent in effective software.
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INTRODUCTION

Since 1982 Computer Assisted Learning (CAL) has been presented by educationists and by government as a major advance in educational practice in Britain. Indeed, few other countries in Europe have provided so many computers in educational establishments as is the case here. Thus by mid-1984 research indicated that 98% of all state schools possessed at least one micro, with an average of 8.7 machines per school (NCC 1986). Concurrent with this provision the Micro Electronics Programme attempted both to make teachers aware of the role that the computer could play and to provide essential training. Such developments have absorbed a great deal of money. However, despite the efforts of MEP and earlier work by the Schools Council, NDPCAL and voluntary groups such as MUSE and GAPE the development of CAL has been slow. Evidence produced by a sample of secondary schools indicates that the use of Computer Assisted Learning in Geography is very limited. A number of factors have been identified which may account for this lack of success. The two most critical factors would appear to be the access that teachers have to computer facilities, together with the nature of the available software. It is also likely that the use of computers is appropriate for only a proportion of the skills and concepts that form the current geography curriculum, even were suitable software to be available.

The study concludes by demonstrating that the potential of computer assisted learning still has not been demonstrated,
but that from the work that has been done it is possible to identify the directions in which further developments are necessary and some of the existing barriers to acceptance and implementation of the work that has been done.

However, even within an apparently gloomy scenario there will be many teachers who have found the medium of great interest and value – these pioneers have a great deal to offer since they are laying the foundations for future development and expansion of CAL usage. Taking the above as a starting point this project investigates, via a limited survey of LEA's and the practice of a sample of CAL users, the probable extent to which CAL has been taken up by Geography departments in secondary schools. It further attempts to identify the problems of both hardware and software that have influenced the rate of adoption of the medium and also to evaluate, in terms of teacher and pupil attitudes and perceptions a selection of the software in current use. From this starting point this paper will develop the concept that it is the practices within schools together with the views of practising teachers, despite their limited experience of the medium, that provide the best indications as to how the technology is, and should be used, together with an insight into the forms and styles of software that are considered effective. Thus it will provide a measure of the success of CAL as an educational tool, at least in the hands of those prepared to experiment with something new and unfamiliar.

This paper thus proposes two main hypotheses, viz:
1(a) That there are areas of geographical education in which CAL techniques can most appropriately be employed.

(b) The characteristics of software that best promotes effective learning in these areas can be identified.

The first part of this hypothesis is concerned with the contribution that the computer is able to make to the learning process per se. However, in the context of this study it is a variable that will depend to some extent upon the curriculum of the sample schools and the nature of the software that they have available. Part two takes the view that not only should there be software packages that are relevant to the appropriate areas of geography but that they should be designed to promote the right sort of learning most effectively. It may not be appropriate to assess them in comparison with existing teaching methods whose objectives may well be different but they should be assessed against the objectives which can be agreed by practising teachers.

In the context of this hypothesis the term effective learning is considered to refer to learning in which a pupil, with regard to his/her ability is able to develop skills, understanding and acquisition of knowledge in accordance with the aims and objectives of the lesson(s). Whether such
objectives are reached must rest with the professional judgement of the teacher concerned. Thus effective CAL is considered to be that which the teacher perceives as creating the above situation either as well as, or better than, traditional methods.

The second hypothesis concerns itself with the constraints under which teachers must work, thus it states that:

2. Access to hardware is a significant limiting factor in the development of CAL.

It thus focuses upon the concept that the failure to make greater use of the computer may have as much to do with the limitations imposed by the difficulty of gaining access to the machines as to any inherent limitations of the technology itself. Thus the survey specifically asked respondents to identify problems in this area for if the motivated are operating under such a handicap then there are serious implications for other teachers.

The research program falls into two distinct parts. An initial survey attempts to ascertain the breadth of software in use in schools. In so doing it also helps define those areas of geographical education in which CAL is currently used. The second area of study concerns itself with the evaluation of a number of software packages by both teachers and pupils. An evaluation of these studies will serve to indicate both the overall role that Computer Assisted
Learning currently plays in our secondary schools and will further, allow conclusions to be drawn concerning the effectiveness of the medium as an educational tool.

The Extent of CAL Use in Secondary School Geography

A key aspect of this research is its confirmation of the limited take-up of CAL in our secondary schools, despite the fact that geographers have been in the forefront of the information technology revolution in education. However, none of the groups studied produced evidence to suggest that the sample was not typical.

The study was based on a number of sources. The initial intention was to restrict it to Hampshire as a typical example of shire county practice. However, given the small number of responses this was not possible. Indeed, of the 117 secondary schools only 26 were reported by Carr (1985) as using CAL in geography during 1983-4, with only a further 14 intending to make use of CAL in the foreseeable future. Given the early expectations of CAL this is an extremely low figure, representing only some 22% of departments. My own researches indicate that this figure has not increased. Such figures are further confirmed both by Jones (1987) study of Hertfordshire and by my own "snapshot" survey of a sample of LEA's in early 1987. The latter indicated that typically only five schools or less were making any regular use of CAL. This being true even of large authorities such as ILEA.
With such a limited user base the study required to be extended. Thus to gain the views of more experienced users members of the Geographical Association software review panel were approached. This was followed by a questionnaire survey of LEA advisers in order to ascertain the schools in their areas using CAL. A number of useful contacts resulted. It is thus clear from both the responses to the surveys and the difficulties experienced in searching out CAL users that far from being a tool used by the majority the computer is, in fact, the prerogative of the few.

The reasons for this situation are many and varied. However, two key issues are raised, the problems that many teachers find in gaining access to computers and the quality and nature of the software that is available.

**Problems of Access to Computers**

It should be obvious that if access to computer equipment is not readily available then teachers will be discouraged, if not actually prevented from using the medium. Despite the fact that almost all schools have at least one computer and most have many more, the problem remains, certainly as regards humanities subjects, and more generally. Indeed, Fife-Schau et al (1986) found that 58% of secondary pupils had never used a school computer, a figure rising to 80% if less than monthly usage was considered. Perhaps this is not
surprising when in my own school there are a mere 12 computers between 510 pupils, of which one only is available for immediate use by geographers.

Faced with this problem it is not surprising that many early users of CAL have not developed it use further. Until computers are readily available there remains little incentive to gain the skills necessary to make full use of them. It may also provide a useful scapegoat for those reluctant to embrace micro-technology for in contrast to industry and commerce teachers appear remarkably conservative in this area.

Even where micros are available for use in class most geographer will be limited to either a single departmental machine or face the difficulties of gaining access to a computer room dominated by Computer Studies, TVEI courses etc, a continual complaint of many respondents to the survey. The simple (!) answer to this difficulty is to provide more micros in schools.

**Software Questions**

A further fundamental difficulty relates to the software itself, both as regards the form that it takes and the curriculum areas for which it should be designed. There is further the question as to whether the software is of a quality such that it is of use at all. By teacher evaluation of selected items this paper attempts to answer some of these
questions from the viewpoint of the classroom practitioner.

There has however been considerable debate concerning the matter of educational software, Self (1985), O'Shea (1985, 1986) and Chandler (1984) having written at length on the subject. Their conclusions were not complimentary but did not of course represent the views of secondary school geographers, as such which is the purpose of this study. The teacher with limited skills in CAL usage may be frowned upon as an evaluator by IT experts, yet the fact remains that teachers have developed enormous skill in assessing educational resources per se. CAL materials are only another educational resource, although one with which the teacher is unfamiliar, but which can be compared and assessed against existing yardsticks.

Thus, for example a computer simulation will be assessed against a similar manual version. These in fact represent the form of software that teachers currently find of most value. Indeed, in the infancy of CAL, Lewis (1979), writing in the preface to the documentation for the Schools Council Computers in the Curriculum Project noted the value of the computer in developing enquiry based techniques and considered that the structure of computer materials should create activities that are primarily problem solving. This can be done through simple games or, more efficiently, though use of a computer simulation with its capability of providing instant feedback. Similarly drill and practice materials and techniques of data handling already exist. Good computer
software should enable teachers to use them more efficiently and effectively. By using the newer techniques in comparison with other methods teachers will not only come to understand those areas of CAL most appropriate to geographical education but also the intrinsic characteristics of good software.

In their initial experiments with CAL teachers will of course be constrained by the available published software. Thus their experiences will relate only to those areas for which such material is available, regardless of whether this represents the best use of the medium or not. One aspect of the study will attempt to demonstrate this situation and to show that commercial software may be dominant in deciding where CAL is used, although there are those (Carr 1985) who consider that teacher originated material may yet prove dominant.

However, a major problem exists regarding the review of software. For while teachers, as noted above, often have considerable experience in the evaluation of teaching materials their experience of CAL is limited or non-existent. Thus in order to use CAL methods the teacher must first identify software relevant to the curriculum and then assess its quality. In this it is suggested that there may be considerable difficulties since, despite the guidelines to software evaluation issued by such diverse bodies as MUSE (Micro Users in Secondary Education), MEP (Microelectronics in Education Programme), and a variety of independent authorities, few teachers have sufficient
experience to make in-depth judgements of the value and effectiveness of software. Nor do they have the time! As Johnston (1987) points out, whereas a book can easily be skimmed or scanned and returned to at will a computer program requires to be run in real time and explored in detail. This is not an easy exercise in many schools. Thus the average teacher will tend to rely on published reviews, which in themselves may be of a largely subjective nature, or simply upon an instinctive reaction to programs seen, for example at a software exhibition.

However, real evaluation can only take place through regular use of the program. Only then will the user become aware of the good and bad points of the package. This will however, tend to take place in a relatively unstructured way which may ultimately have little validity. It is thus important that a program is evaluated in the light of its intended purpose. For example, a simulation is designed so that students will be able to explain how the factors affecting a system interact, while a drill and practice package is designed so that students will be able to recall the factual material covered. They require to be evaluated in the light of their success in achieving those objectives. The evaluation questionnaire was designed with this purpose in mind. However, it must be noted that there is no positive way of knowing that the respondents were actually using the software for the purpose for which it was intended, although not to so do would cause the respondent difficulties in completing the questionnaire. Once such evaluation had taken place it is possible to
identify those elements within a package or program that prove most effective. If these can be identified and applied to future software development then it may be possible to avoid many of the problems and arguments that have become apparent as our experience of CAL moves from a stage of youthful exuberance to the more thoughtful and reflective mood of maturity.

Indeed, many criticisms have been levelled at software currently available, both in Geography and other subjects. As early as 1980, when educational computing was in its infancy Shepherd et al (1980) commented vigorously on the inadequacy of educational software, being particularly critical of the drill and practice and tutorial forms of CAL that made up much of the available material at the time. Yet the need for good software had been recognised many years previously, Patmore (1975) stressing the need for large amounts of good software, while Lewis (1979) noted the type of software that was desirable but did not then exist. Such developments are fundamental to the use of CAL for as Walker (1981) suggests, the development of CAL in Geography as in other subjects, may well be influenced more by the nature of the software than by anything else.

However, this is not to say that good quality software does not exist, for while responses to this survey suggest that there is certainly low quality material about there is also much that is good. Further, as teachers become more critical and programmers more experienced in the design of educational
materials the volume of good quality material will increase. Thus O'Shea (1983 & 1984) and Bork (1983), who as computer scientists and information technologists are remote from the realities of the classroom but have so heavily criticised educational software, will be proved wrong.

It is thus contended that the key to software development will revolve around the extent to which the views of the classroom teacher are take into account by publishers and software authors, for it is they who are able to see at first hand whether or not a program is effective both for them and their pupils. Indeed, development work by David Walker at Loughborough and Deryn Watson at Chelsea College, together with that of ITMA (Investigations of Teaching with Microcomputers as an Aid) has largely been based upon the active involvement of teachers, with considerable positive implications for the materials thus developed.

However such welcome developments must have regard both to the slow pace at which the computer is being absorbed into educational thinking and also the way in which new directions for information technology in schools are being perceived and investigated. The speed of progress since MEP began in 1982 has been rapid with a range of LEA and university based initiatives sometimes seemingly vying with each other re-invent the wheel, in spite of the supposed coordinating role of MEP. This is in sharp contrast to West Germany where careful research has taken place in advance of of significant CAL development, (Lauterbach, reported in TES 25/10/85).
In the future new initiatives to extend the use of information technology across the curriculum may also prove significant. Certainly they will change not only the teachers perception of the way in which the computer should be used in the classroom but also the nature of the software itself. This paper and others like it can only give indicators of the way in which this development may take place for we are approaching a rapid expansion of CAL usage in education while at the same time awaiting equally dramatic changes in school curricula - an interesting scenario for the future!

Financial Constraints

Although good quality software is available the lack of it in schools is due as much to financial constraints as to the software itself. This is particularly so when curriculum developments such as GCSE are tending to take priority. The problems of financing software purchase was a common complaint of respondents to the survey. Even allowing for MEP subsidies software is not cheap, though without subsidy it is unlikely that many publishers would have been able to bear the development costs of good quality material. Conceptually sound, well written and robust programs are expensive to create and given the small sales volumes of subject specific software such costs will form a significant part of the price, although in the absence of evidence from the publishers themselves this must be considered as no more
than informed conjecture.

It is possible that teachers may purchase the cheapest software for a specific task without regard as to whether it is actually the most effective for the purpose. Thus the sample of software evaluated for this paper may well not represent the best that is available although teachers may well consider it effective for the task for which it is used. Indeed, since the majority of respondents to the survey are active users of CAL they could thus be considered as having pre-existing ideas as to the value and role of existing particular software. There remains also the problem of those who are not currently using CAL, for their perception of available software may be the deciding factor in their decision not to become involved. The structure and scope of the research did not allow these particular problems to be adequately investigated although in hindsight they may well be significant.

Report Structure

The report that follows falls into three sections. The first provides an overview of the current literature, together with a discussion of the implications of present developments on CAL applications and software development. This is followed by an analysis of current CAL usage and an analysis and evaluation of a sample of software currently used in schools.

It is hoped that the findings of this project will provide
some of the answers to questions surrounding current computer usage in Geography, notably the levels of use and the difficulties encountered by teachers in its development. In particular it will identify features exhibited by successful software, together with those areas of geographical education where CAL is able to make the greatest contribution.
CHAPTER 1

The Development of Computer Assisted Learning

Computer technology can be applied to education in a variety of ways. In particular it has been advocated and used within education as a teacher surrogate in the programmed learning style, and alternatively, as a tool with which to remove barriers to study and learning. While both approaches may be considered valid the study will show that the programmed or CAI (Computer Aided Instruction) approach, while of benefit within a narrow training situation, does not make the best use of the resource as an educational medium, where it is of greater benefit if used as a learning tool rather than a simply a means of delivering information.

History and Background

Although it may seem remarkable to us today, surrounded as we are by the supposed "new" computer technology, the history of computers in education may be traced back over a quarter of a century, and its antecedent, programmed learning beyond that. It is this latter concept, resulting from the work of Skinner in particular that shaped much early thinking in the USA and is still echoed by the ill informed and, unfortunately, the educational media. For example, Venning (TES 1978) considered that, "Programmed learning may suddenly find a new respectability", and that (using computers), "education may be expanded substantially and class sizes of half a dozen
might become quite normal".

When such ideas are propounded the teacher who junked a 1960's "teaching machine" to the dusty recesses of a school storeroom may be forgiven a feeling of deja-vu and a gut reaction to reject the computer in the same way as the old teaching machine was rejected. Shepherd et al (1980) regarded CAI as merely, "yet another fad fading into the background", and concluded that it was neither effective nor educationally sound. Jones (1984) considered CAI as a "failed dream". However, as will be shown, work in Britain, based upon a less restrictive philosophy, clearly demonstrates the unique potential of the computer as a learning tool.

a) Development of CAI based on the programmed learning approach - the experience of North America

It is perhaps significant that much American work on computerised teaching systems took place in an institutional setting as part of major and well funded projects. Indeed, it is that very institutionalisation that has led to a narrow approach to computers in education in comparison with that in Britain, where research has been on a much smaller and informal scale with considerable teacher input, and in particular the almost religious fervour with which the concepts of one man have been embodied in the developments.

Skinner, a psychologist perhaps best remembered for his
famous rat experiments developed the theory of programmed learning. He has much to answer for, and while this paper is not the appropriate place to consider his work in detail it is important to understand the basic tenets of his theories. These revolve around the idea that by breaking down subject matter into a series of discrete and logical steps, each of which must be understood before the learner can progress to the next. This progression being either in a linear manner, or via a series of branching exercises, each providing reinforcement of material previously covered. Thus a student will rapidly learn a particular concept or block of information.

When these theories were propounded and the first rudimentary teaching machines, mechanical monstrosities of paper rolls and slide projectors, were developed in the 1960's they were hailed as a vision of the future - children could work at their own pace, learning would be individualised, skilled teachers would no longer be needed at a time of teacher shortages) and the system would be cheap. Much the same has been said in our own decade about the role of the microcomputer in education.

This is not to say that the approach is not valid under certain circumstances. Indeed, in industrial and commercial training, especially if linked with the new interactive video-disc it is of considerable value for skills training and the teaching of of basic concepts. Indeed in terms of skills training it has its place in school geography, eg in
the teaching of OS map work. This role is, however, limited.

Thus it was against the background of Skinner's ideas that the earliest attempts at the use of computers as an instructional medium took place in the USA. The emphasis was indeed upon instruction rather than learning in the European sense, hence the American term CAI ie Computer Aided Instruction as distinct from the European concept of CAL, Computer Assisted Learning. Early developments involved, of course, the use of mainframe computers which would seem to us today to be amazingly primitive. Two experimental systems developed, PLATO and TICCIT.

PLATO, Programmed Logic for Automatic Teaching Operation was the first of these systems, PLATO I beginning in 1960 at the Computer Based Education Research Laboratory of the University of Illinois. The implicit aim of the development was to produce a ubiquitous teaching machine, available to all those schools and colleges who wished to make use of it. The system was, in reality, a highly sophisticated teaching machine, based upon the programmed learning approach. The weak link in the development related perhaps to courseware ie the programmed learning package and its documentation. This was based around an authoring system, using the language TUTOR, which avoided the need for its originators to be programmers. However, there was little real organisation of this vital aspect, resulting in material of a very variable nature (O'Shea and Self (1983)).
Other problems were encountered with the technology of the system as it passed through various stages of development, culminating in PLATO IV by 1975. The final technology, using very expensive plasma display screens to accommodate back projected slides as well as computer generated text, plus touch screen communication together with the large number of terminals required for the system to become economic were all against it. Micro technology and the interactive videodisc rendered such leviathans redundant overnight for they avoid the enormous costs and inherent unreliability of such a system. Perhaps however, PLATO would have died anyway for it seemed to be no more effective than other methods of instruction. O'Shea and Self (1983) note that the project concluded that the use of PLATO had no positive or negative effects on either student achievement or on drop-out rates, nor was it cost effective when compared to traditional methods. However, they note that the system had been found effective with regard to high level staff training in industry, resulting in the development of a simplified micro based system which is proving cheaper and more effective.

Similar problems applied equally to the TICCIT system, Time-Shared Interactive Computer Controlled Information Television. This system, set up in 1971 by the National Science Foundation of America, via the Mitre Corporation aimed to demonstrate that CAL can "provide today better instruction at less cost that traditional instruction in community colleges", (O'Shea and Self (1983)). Despite the wealth of evidence to the contrary, documented for example by
Morrison (1975), Howe and Du Boulay (1971) and O'Shea and Self (1983) it still seems impossible to give this wildly inaccurate expectation a decent burial.

A basic premise of the system considered that the effectiveness of a particular learning strategy is independent of subject matter (Bunderson (1975)) hence content can be separated from both programming and teaching strategy. Yet the learning process cannot be broken down into convenient parts or subjected to a form of systems analysis. The inherent faults of the system may be illustrated by the comments of Morrison (1975) who noted that the initial presentation of the system to the college faculty was a total disaster. Whether this attitude was because of or in spite of Morrisons (1975) opinion that, "A thorough indoctrination into the background of the educational values embodied in the TICCIT helped to dispel the mistrust of man-machine systems" is not obvious. However, surely if one needs to suffer indoctrination into a way of thinking then there is something seriously wrong with the concept in the first place.

Ultimately the end-user, the student, provides the best indicator of the value or otherwise of TICCIT. Although students using the system were claimed to achieve higher post-test scores than those on normal courses the drop-out rate was high. O'Shea and Self (1983) noting only 16% of students completing a maths course compared to 50% taught traditionally. Student response was similarly poor in other
faculties. The system was not adopted by colleges other than the two involved in the experiment.

Effectively both these systems must be considered as failures both educationally and technologically. By continuing the philosophy of the pupil as an empty vessel to be filled with suitable selected and compartmentalised knowledge they ignored the role of education as a means of developing thinking, flexible and adaptable adults rather than programmed automata. That this approach might be considered in a subject such as Geography, with its complicated and often confused relationships between man and environment, and involving so many value judgements might seem strange today. However, even in the early 1970's realism was dawning. Fielding (1974) considered programmed learning units to be supplementary to a textbook rather than a replacement for it. He considered that: "There is no doubt that CAI is superior to programmed manuals if cost is not a factor . . . also facilitates presentation of the dynamics of behavioural processes that the geographer seeks to understand. Despite the inevitable programmed approach implied Fielding further noted that most students, "enjoy using CAI. Learning is self rewarding . . . . Tests have also demonstrated the superiority of CAI in achieving long-term learning goals." He ignored however, the problems of motivation, drop-out rates, cost and the lack of improvement in test scores found by most users of TICCIT and PLATO. Thus although the potential of computers as an educational tool were apparent they could not, at that time, offer any tangible benefits.
IN the UK it was inevitable that similar experiments should be tried. Broderick and Lovat (1975) comment upon a mainframe based system developed in Havering. They conclude that such a system might allow for the full automation of the teaching/learning process with the teacher remaining in the role of tutor and counsellor, merely providing guidance for the computer managed private study of learning tasks set by the machine.

The continuation of such attitudes is one of the more unfortunate aspects of the development of CAL for we do not always seem to learn by our mistakes nor realise when we have entered an evolutionary dead end. As a means of providing drill and practice exercises and of presenting discrete packages of information in programmed form the computer is a more than willing (and ideal) tool. Yet this has not been proved to be the way in which it should be used, despite which Hudson (1984) and others continue to provide guidelines on using it in just such a way. If this is to be the legacy of the PLATO and TICCIT exercises it will be unfortunate for their real benefit lies not in their failures but in the success of their approaches to courseware development, a point noted by O'Shea and Self (1983). Even so, these authors note future dangers. The micro might have made vast mainframe systems redundant, but, teamed with the developing technology of interactive videodisc a miniature TICCIT or PLATO style system becomes feasible at little cost. As O'Shea (1985) notes, "This is ominous: the videodisc
encourages the freezing of chunks of teaching material and a reversal to modes of teaching which have not been found effective." This is indeed a danger, but one which can be avoided, as is currently being demonstrated by the work of Beddis and Walker in this area.

The Development of CAL in Britain

It is not surprising that Britain, despite Harold Wilsons expectations of the "white heat of technology", but stumbling from one financial crisis to another, should not follow the American route. With the exception of the scheme in Havering mentioned above together with some work in universities, development of CAL in Britain was limited, although the potential did not pass unnoticed. A number of low budget exercises were undertaken which have had a profound effect on both the nature of CAL in Britain today and on the software in use. Whether these are likely to result in stagnation rather than opening the door of a new "golden age" remains to be seen. Ones viewpoint on this depends upon whether one supports the pessimists typified by O'Shea (1985) and Self (1985) or the optimists such as Kent (1985) and Middely (1985).

While Skinner shaped much American thinking the guru of British practice was surely Lewis, who through his work with the Schools Council laid the foundation of British CAL. His philosophy centres upon the investigative approach to learning, pushing pupils towards asking the question "what
would happen if . . . ?, with the computer merely as a tool
to achieve this end rather than as a means of instruction in
itself. Thus the computer came to be used for problem
solving via the use of simulation, gaming and model building,
although a role for data retrieval and computation was also
noted. Throughout there was an intention to ensure that,
"material is not presented by the computer in isolation",
and to, "avoid structuring too closely the way in which the
material should be used". Although written in 1979 this
attitude summarises well the British attitude to CAL today.

Developments in Britain operated at two levels as represented
by the "official" work, ie state funded, as in the case of
the Schools Council Computers in the Curriculum Project and
the National Development Program in Computer Assisted
Learning (NDPCAL) together with the MEP funded Geographical
Association Package Exchange (GAPE) on the one hand and
Micro-Users in Secondary Education (MUSE) and similar bodies
on the other. Between them these various projects and
informal groups laid the foundations of CAL as it appears in
British schools today.

NDPCAL formed a five year investigative programme into the
nature and role of CAL between 1972 and 1977, based on
mainframe machines. Walker (1982), writing at the time that
microcomputers were becoming generally available, and thus
looking to these as the future of educational computing,
considers that the end of this project marked the end of
"what might be called the first phase of educational
computing in Britain." Of more significance was the move away from the "stereotype of computerised programmed instruction . . . ", and a move towards what the Carnegie Commission on Higher Education considered to be the the future role of the computer, ie " . . . its true role should be in the enrichment of learning, complementing rather than replacing current learning methods", (Rockhart & Scott Morton (1975)), quoted in Walker 1982). This is precisely the approach adopted by Lewis - the computer as an aid to understanding rather than as a teaching machine.

This attitude to CAL is well illustrated by the programs developed by the Schools Council Computers in the Curriculum Project at a time when few schools had access to any form of computer let alone the desk-top micro that is now so familiar. There existed however, some material upon which to build. Mainframe programmers had begun to experiment with simple games such as HURKLE, a coordinate exercise, while number crunching programs were easily written and could be used for batch processing on mainframes. Indeed, the first programs developed at Chelsea College were written on a mainframe and subsequently adapted for micros when the arrival of the CBM PET and early RML 380Z provided real opportunities for educational software development. These programs, in a much modified form, are still available and, on the basis of this research, still selling well.

The program pack consisted originally of five programs, of
which four can be considered as games/simulations. Of these perhaps FARM and MILL are best known, particularly as they were aimed at the 11-16 age group. Developed originally as text only programs they appear primitive today in comparison to modern programs using high resolution graphics, yet they were in fact created as a carefully contrived part of a complete unit of work. This is in fact a key point, for the computer was not put into the role of teacher, it became merely a tool for handling information and presenting it to the pupil who was then left to draw suitable conclusions under the guidance of the class teacher. The programs performed this role admirably.

From these beginnings were spawned a number of other well thought out and useful packages such as ROUTE, RICE and WINDS, all of which follow the same simulation methods. Concurrently other programs were developed to make use of the computers other great ability, the rapid handling of information. Thus DEMOG 1 and 2 handled population data and drew population pyramids while MORPHO handles drainage basin statistics. These packages, together with others such as SPITSYM set the pattern for the way in which the computer would be used in UK schools once the micro revolution began.

 Concurrently with these developments GAPE and MUSE helped to build up a small but extremely important pool of expertise which could be tapped and used as a foundation for work in schools. This indeed proved of enormous value once the Microelectronics in Education Programme was underway. The
key aim of this project was to create a situation in which children would be alerted to the ways in which the microchip will increasingly change office and factory work and to use the computer to enrich the study of traditional subjects. Later a further aim emerged, notably to help teachers acquire the skills and educational materials needed to enable the computer to be used as an aid to teaching and learning. Given the tiny minority of teachers who, on the basis of this research have any real computer expertise, and the even smaller number who actively use CAL in their lessons the program cannot, from this viewpoint, be considered a success. Perhaps it was indeed hampered, as O’Shea and Self (1983) consider, by the associated Micros in Schools scheme, by which grants were made to enable schools to purchase at least one micro and which has resulted in schools becoming tied to one rather esoteric brand of machine which does not conform to industry standards.

This does not necessarily create major problems for the user who simply wishes to interject a program into a lesson in the same way as is currently done with, eg transparencies and OHP foils. The elegance of the program, the language in which it is written and the internal workings of the hardware are of little concern here, compared to the teaching points that are illustrated. Similarly in project work the student is concerned with the computer as a tool, not with the inner workings of the package. To this extent simple and robust technology is all that is required. Thus the typical BBC
micro with its BASIC language is suitable for all simple purposes, provided that it is equipped with a disk drive. The real test of its efficiency is whether or not it helps the pupil to progress. If a simile with transport may be drawn, a Rolls-Royce is very nice but a Morris Minor will still get you from A to B.

However, as programs become more complex the limited memory, with the need to frequently read new data from disk, causes such machines to be very slow and frustrating in use. While ultra-high resolution graphics may do little to enhance the educational value of a program, and icons are of little benefit where a program may be driven by three keys it must be accepted that the typical school computer is now looking somewhat dated in comparison with the typical PC compatible home computer. Teachers must however make the best use of the equipment that they have available, although their expectations of the computer will increase with time.

Perhaps many of these problems might have been avoided had the Department of Trade and Industry scheme to provide micros in every school been better organised. By extolling the virtues of the computer, and the BBC machine in particular, teachers, untrained and with no experience of computers upon which to draw were given expectations that the software, appearing some time after the machines had reached the schools, could not fulfil. This, coupled with a subsequent training programme that was largely piecemeal and voluntary has proved a barrier to the full development of CAL.
Indeed, much of the available INSET has been concentrated merely upon the use of the BBC Micro itself and to some extent the irrelevant (for most teachers) skill of programming. Certainly in Hampshire there have, to date, been no courses that concentrate upon the use and evaluation of software, whether in Geography or any other subject, although there are indications that this oversight will be remedied in the future. Perhaps this is the fault of advisers, for they are generally experts in Computer Studies or Information Technology and as such unable to appreciate the INSET requirements of the Geographer in the way that a computer experienced subject adviser would be.

However, all is not gloom and despondency for MEP, for all its faults, served a number of useful purposes. In particular it helped make teachers aware of the possible roles of the microcomputer, even if they subsequently failed, for whatever, reasons, to make use of them. Further it aided software development and made available a range of public domain materials, although of very variable standard.

Perhaps its key contribution in this area was in fact financial, for by subsidising the price of selected items of software it enable schools, always short of money, to acquire sufficient software to experiment with the medium. Without such a subsidy packages such as the Cambridge/Netherhall MAPSKILLS 1 & 2 (1983) and the Loughborough developed MEP/GAPE package (1984), published by Hutchinson, might never
have become available. Now that MEP has faded from the scene will its successor continue this good work? If not schools will have to fund the full commercial price of software, a price which may be beyond the budget of many schools, for with a small market the price is likely to be high in comparison with, eg the vast range of cheap material available for PC compatibles. It would seem unlikely that even the DTI scheme for 50/50 funding of purchases will have a great effect on purchases by other than Computer Studies departments, assuming my school is typical.

A department such as my own, with an overall budget of £1150 in 1987-8, and faced with the high cost of GCSE developments may be able to allocate only around £50 a year for special purchases once essential books and consumables have been bought. Indications are that many departments will spend such limited funds on, eg fieldwork equipment rather than software. Thus only one or two items may be purchased a year—hardly an incentive for software houses to develop new materials. Despite this pessimistic picture there is hope on the horizon in the form of licensing schemes being negotiated by various LEA's and these may prove one way forward. Other routes might include a version of the "shareware" philosophy or the setting up of software libraries in teachers centres.

Only time will tell, for while the tender plant of CAL has taken route in almost all schools in Britain it may yet fail to thrive if nutrients in the form of good software at an economic price are not forthcoming. Given the parlous state
of education at the time of writing, together with the dramatic changes that are coming in the 1990's, the omens are not good. However, both the computer and Computer Assisted Learning are with us and will neither go away nor be ignored.
CHAPTER 2

TYPES OF SOFTWARE AND THEIR USE

Various styles and modes of software have been developed for use in Geography teaching. It is thus pertinent to consider their development and to assess their importance and spheres of influence in relation to the broad tenets of this project.

Classification of materials

The outline of CAL development in the previous chapter indicates clearly the broad dichotomy of thinking between ourselves and North America in the use of CAL methods in education as a whole. This point was noted by a report of the NCC on standardisation in educational computing (NCC 1986), which indicated a broad range of computer use in UK schools. This same report attempted to categorise the educational objectives associated with the use of computers in schools and this, perhaps, provides a useful starting point, illustrating as it does, the "official" thinking of those with the funds to direct the development of both hardware and software. The objectives noted that are relevant to Geography are as follows:

- To provide an additional resource for the student, for example for information retrieval; for word processing, spreadsheets etc; to aid in complex
calculations; as a "fun" learning tool and for revision and drill and practice.
- To provide an additional resource for the teacher, for example enabling demonstrations using computer models of real situations; acting as an electronic blackboard.

(NCC 1986)

Although the former tends to perpetuate the CAI concept, although in a limited way the latter confirms the development of the roles indicated by Lewis in the 1970's.

As stated these objectives would seem to apply most aptly to CAL as it is currently used in secondary schools generally and, more specifically in the way in which it is used by geographers. It neatly summarises the views such as those of Forer (1982) and Maddison (1983). However, a number of avenues for CAL development exist. Watson (1984) comments upon its role in decision making and sees, "an environment in which pupils ask questions for themselves, deciding a path to follow, and seeing the impact of their decision on the screen". Such an effect may be achieved both by simulations and data handling software. Walker (1982), quoting the work of Rockhart and Scott Morton (1975) suggests that the true role of CAL, "... should be the enrichment of learning, complementing rather than replacing current learning methods".

Thus it is perhaps necessary to break down these broad
generalisations into those areas and forms of CAL are educationally most appropriate and to relate them specifically to geography teaching before considering them in relation to the research data.

Forer (1982) notes five main applications for computer techniques in geographical education viz: simulation, CAI in both drill and practice and tutorial forms, data banking, cartography and gaming. This classification is widely accepted by many other users and although such areas as data exploration (Shepherd et al (1980)) and problem solving (Edwards (1975)) may be included they are really only branches of the divisions outlined by Forer. Perhaps the only criticism of Forer's analysis of the subject is the division of simulation and gaming for these are so closely intertwined as to be indivisible since many simulations involve a gaming element - relating to the game of life if nothing else. It must however be accepted that in geography some simulations are purely that, eg as illustrated by the program SEA-CLIFF EROSION, where no obvious gaming element is involved.

However, educational computing has now undergone several years of development and various styles and modes of software have become available. Given this situation some form of simple classification is essential if their development is to be understood and considered in the light of the research data. Thus for the purposes of the evaluative section of this paper the following classification, an amalgam of the work of
Forer, Shepherd, Midgely and others has been adopted:

a) Simulations and games
b) Tutorial/drill and practice
c) Data handling/quantitative
d) Content free/nonspecific
e) Unclassified

This classification, while apparently simplistic, does comprise those areas of CAL that relate directly to its usage in schools today, and also to the objectives for CAL noted in the 1986 NCC report. It will be noted that the classification is based upon the nature of the software itself and makes no attempt to include the actual mode of use. This is deliberate since the way in which the material is actually used in schools often bears no relation to that intended by the author due to factors previously discussed.

The criteria by which programs are classified is quite basic. Within "simulations and games" are included all those programs that in any way simulate real situations or involve a game based upon real situations. In both cases a degree of pupil/computer interaction is assumed together with an open-ended result. "Tutorial and drill and practice" materials are those that adopt either a CAI approach, provide practice at basic mechanical skills or are simply video quizzes. The classification of "data handling and quantitative material" is rather more complicated, given the wide range of such programs. Data bases and programs that perform simple
statistical calculations are obviously within this category.
"Content free and non-specific software" is taken to be that which does not teach a specific aspect of the subject but may be used in a variety of constructive ways. Packages such as EXPLORER and INHABITANT fall into this category, as do tool kit programs such as word processors, graphics packages etc. Finally there will always be those programs that defy classification, though one must be careful that such a group doers not become a convenient catch-all.

The above classifications relate to existing teaching strategies. Given the relatively small numbers of micros available in schools, together with the natural conservatism of the teaching profession, CAL will not result in a dramatic change in methods and techniques. Rather the teacher will absorb the computer into his existing modus operandi and will adapt gradually to the new opportunities offered by CAL. Certainly he is likely to approach with caution the many theories as to how the computer should be used in education. What concerns the teacher is whether the computer is able to improve and enhance already familiar techniques such as games and simulations, or can teach mechanical processes that many lower ability pupils in particular find difficult eg map skills such as grid references and the handling of statistics and fieldwork data.

The basic question will revolve around the effectiveness of a particular software item with a specific class, rather than a detailed consideration of the educational theory behind the
design of the software concerned. This does of course beg the question as to what is meant by "effective", together with the means of measuring this rather vague concept. At its most simplistic level "effective software" will enable a pupil to achieve a specific learning objective. This may or may not be accomplished more quickly than through existing techniques. Truly effective software, which justifies the use of expensive computer resources will not only enable learning objectives to be reached but will allow this position to be achieved both more quickly and efficiently for the majority of pupils in a class. This is the yardstick against which it will be judged. It must however be stated that what will be effective with one class may be an abject failure with another, for one is, after all, dealing with individuals. Such a situation is however, no different from that found with other techniques - none are perfect in ALL situations.

Thus the teachers interest will lie in what the software can actually do to improve his pupils understanding of a particular concept or to aid their personal research. However, it must be recognised that at this stage in CAL development there are few teachers with the skill to assess whether a package will work in the intended way in a particular learning situation. Ultimately, software that works will not only be based upon sound educational theory but will also have stood the most demanding test of all - the classroom.
CAI versus CAL—the Current Situation in Relation to Geography Software

The concept of the computer as a teaching machine is one that has proved very hard to dispel, and while there is doubt sown in the minds of the consumer as to the ability and effectiveness of the human teacher there will remain those who are convinced that machine can do the job more effectively. Such a concept was proposed by Morrison (1975) in relation to TICCIT, while Evans (1979), although dismissive of the early teaching machines, had a vision of personal teaching computers freely available to all by the mid 1980's! Many others fell into a similar trap, thinking that computer literacy and educational home computing were inextricably linked to the sudden market for small memory, 8 bit games playing machines. The raw fact remains that the computer is unlikely, in the foreseeable future, to become a teaching machine capable of taking over the role played by the human teacher, at least in so far as secondary school geography is concerned, although such a role may become both possible and beneficial in certain training applications, as has been noted previously.

However, this does not mean that aspects of CAI do not remain, or indeed are not viable. Although Hudson (1984) continues to push the philosophy of programmed learning, which he regards as the only pure form of CAL, this route is effectively dead in so far as UK developments are concerned. Hudson is extremely dismissive of elements such as multi-
choice tests, drill and practice, games and the like, although surprisingly he does recognise the value of simulations. Such an attitude might be expected from one whose experience lie in industry and not education, yet it is one that in the current climate where schools are being looked at as almost industrial production lines, my well continue to be heard. However, the fact remains that despite many arguments against such forms of CAI they do have their uses in the classroom, albeit in a limited way.

Perhaps the multi-choice test type of program is of the least value, although many publishers have put such programs on the market as supposed revision aids. Similar programs such as WORLDWISE, which test knowledge of the location of capital cities and the like would similarly seem to be a waste of a valuable resource. As geographers we are of course concerned with promoting understanding of the world and the places within it and while basic locational knowledge is essential such rote learning methods, with their narrow base and limited demand on the intellect are likely to benefit few except those who continue to maintain that the sole purpose of education is to pass on a body of knowledge. Perhaps such programs would be of greater value if they could actually teach the much more valuable SKILL of using an atlas. Many programs of this genre were produced for the home market and apparently failed to sell well (NCC (1986)). Not only does this speak volumes about the perceived value of the software by parents as well as pupils but also perhaps indicates that neither of these groups perceives the home computer per se as
having an educational role! Perhaps the only area of geographical education where CAI methods are valuable lies in the area of basic mapwork where drill and practice and tutorial CAL techniques have proved quite successful. Certainly a number of programs such as MAPSKILLS and MICRO-MAPPING have been produced to teach aspects of this skill.

The earliest of these, HURKLE, while not a drill program in the true sense, rather one designed for skill training, did provide a string practice element. It took the form of a simple coordinates game and has spawned much more sophisticated developments such as SHEEP-DOG TRIAL. These programs, while fun, have limited value but do provide practice of basic skills. Other programs set out to teach and test specific mapwork skills eg GRIDREF, probably the best currently available. Others such as MICRO-MAP and GENERAL MAP READING serve to provide drill and practice once basic skills have been mastered. Such exercises are difficult to provide on an individual basis by conventional methods and provided that sufficient micros are available are an excellent and efficient, method of helping pupils who have difficulties with these essential skills. It is in this area that such methods are currently used in school geography, their application elsewhere being rather more problematical. Certainly no software publisher has yet produced material for other areas of geography, perhaps because there is no demand for it within modern conceptually based syllabuses.

A further early application of the computer was of course as
an efficient manipulator of numerical data, an invaluable aid as geography moved towards quantification. Thus it enabled geographers to handle long and complicated calculations with ease and to present the results in graphical form. Midgley (1985) and Maddison (1984) describe this role in detail and its value is beyond doubt, especially in 6th form work though it has a much smaller role to play in the 11-16 curriculum where more advanced statistical techniques are rarely used. However, the ability of the computer to handle vast amounts of data and to help the user make sense of it are of increasing importance. Data on its own is of little value if it cannot be analysed, assessed and compared. Even small amounts of fieldwork or other data can become tedious and time consuming to handle without the aid of a computer and it is here that the micro may well have its most dramatic effect, especially with the emphasis on information handling given by some of the more progressive GCSE syllabuses. A number of database packages have already been developed to a very high degree, notable QUEST/QUERY from AUCBE together with the very similar INFORM. Such programs are extremely powerful but do depend upon adequate teacher training if they are to be used successfully. That publishers have appreciated this role of the computer is notable, as witnessed by such packages as CENSUS DATABASE and GEOBASE. It is probable that the use of such programs will assume greater importance in future years as teachers turn to micros not only as teaching aids but also as tools for themselves, to speed the routine of administration.
These represent, both in my view, and that of many respondents to the survey, the best of the current developments, but suffer from the inadequacies of the present range of school computers, especially the limited memory and slowness of the BBC machines. Despite rapid advances in technology such machines will remain in schools for many years but will be unable to handle the increasingly sophisticated software that will become available. It would be a great pity if development was stunted by the innate inertia and underfunding of the educational system, for in a society in which the quaternary sector will soon predominate the ability to handle information in a meaningful way becomes as essential as basic literacy. Given the current view that information technology skills should be cross curricular geography offers a vibrant and fascinating medium through which such skills can be developed, whether these involve the wordprocessing of fieldwork reports, the searching of on-line databases (eg TTNS) or the use of a simulation to model the planning procedures for a nuclear power station. Such skills, if properly developed become transferable and of lasting benefit.

Such developments lie in the future and perhaps of more immediate interest is the use of the computer for simple simulations and gaming. Forer (1982) notes the dominance of this role between 1978 and 1981 together with its increasing importance by the mid-1980's. Geography of course led the way in the use of such methods and many such exercises have been published. It was therefore logical that computer
versions should appear as soon as the technology was available. The early Schools Council programs such as FARM and MILL are illustrative of the genre. A vast range of increasingly powerful programs of this nature, some extremely complicated, such as TOURISM, are now available, their complexity only limited by the hardware. The importance of such programs is stated by Grummitt (1980) who considered them to be the most significant use of CAL in the whole secondary school. Given that 46% of programs in use in Hampshire schools fall into this category it might be considered that many teachers agree with this view, although it must be accepted that this may be due to the greater availability of such materials.

Some simulations may be open-ended in nature, EXPLORER (actually an English program) being an example, where the user is able to provide his own information from other sources to explore an environment. The role and validity of such programs has yet to be fully researched and appreciated. The same applies to such packages as word processors and spreadsheets. While these, appear to have a definite role in departmental administration they are rarely, as yet used by pupils, perhaps because of lack of hardware as much as anything else.

The present situation has developed piecemeal, without any real planning or guidance, and certainly with only limited research in the UK at least. At the same time early experience in the USA appears increasingly irrelevant to the
developing micro-technology, although recent developments mirror UK experience. It is apparent from research for this paper that two areas of CAL usage are beginning to predominate, notably the use of simulations, which comprise 39% of the software in sample schools, but also of data handling software, comprising 29% of material in schools. At the same time tutorial CAL, which makes up 17% of commonly used software has an important if limited role. However, the evidence suggests that CAL will complement but not take over from, existing methods.

However, we are still only on the fringe of exploiting the opportunities offered by the computer. Indeed many respondents seemed rather pessimistic noting problems of hardware access, software cost and quality and bemoaning their lack of training and experience in the field. Perhaps this reflects the views of Bork (1984) who warns that, "... materials (are) available as bits and pieces ... rather than coherent collections of learning materials." This does appear to be the case, with schools purchasing odd items of software without any clear concept of their curricular fit. It is essential that not only does the software meet specific learning needs but that it forms part of a complete learning package. Certainly materials with an ancestry in the Schools Council work do reach this ideal, unfortunately much does not. Since Longmans, the publishers of this material, seem to dominate the market there is hope for the future.

Yet, despite MEP and similar initiatives the take-up of CAL
to date has been small, while the number of computers per pupil remains low. However, new initiatives on training may well encourage more teachers to take the plunge, indeed, policies for using IT across the curriculum will force them to so do. Even the hardware problem is now recognised, though cost may work against a rapid solution of what is recognised by teachers as a key problem, preventing many from using CAL even when they would wish to.

Although Bork (1983) complained that little good material was available and that, "much . . . including commercially published material, is of very poor quality", this has not discouraged teachers from using it effectively. That good software is of major importance is obvious. However, in the final analysis this must be only a part of the equation. Many factors are at play, from government policies towards education, through the interests of publishers to the views of noted experts in the field. Ultimately, if the hardware and software problems can be solved, the future of computer assisted learning in geography will depend upon the teacher. If the majority of teachers reject CAL then the medium will fall. This may not happen, yet the continued development of CAL must be viewed as a slow and long term process, requiring sound resourcing in terms of hardware, together with software developed with the need and expectations of teachers kept to the fore. It is the teacher and the teacher alone who is the real key to CAL.
Geographers have developed the use of the computer perhaps more than any other subject on the school curriculum. This is perhaps due to the innovations and developments that have taken place in the subject during the past 20 years which have placed it at the forefront of curricular development. Thus as geographers have developed strategies based upon experiential learning, issues based approaches and an increase in investigative fieldwork they have turned to the computer as a means of making such approaches more effective.

At the present time therefore geographers are able to use the computer in a variety of ways eg:

- as a means of collecting, storing and retrieving data, including use of on-line searching
- the use of simulations and similar "what if . . . " planning exercises
- communications via EMAIL
- word processing
- reception of satellite transmissions eg from METEOSAT
- desk top publishing and viewdata

In the future, as teachers gain in both training and
experience these areas will be developed, as will new technology such as interactive video, which is rapidly being adopted by commercial organisations such as British Airways. Teachers will thus be able to operate in ways appropriate to the developing curricula using techniques not possible without the use of computers. It is recognised that this ideal situation noted here and echoed by Fox and Tapsfield (1986) may be some time in coming. Thus it is pertinent to look at the current situation and to see just how far we have travelled along this unmapped road.

**Background**

A basic tenet of this research is that it is the teachers assessment of the role of CAL that is central to future development. Thus the research tools were designed specifically to ascertain the attitudes and opinions of both regular and other CAL users regarding both the role of CAL and the evaluation of software. They serve to assess teacher opinion in a subjective manner since it is considered that this is of considerably greater validity than, for example, the objective evaluation approach adopted by eg ITMA.

This stance has been taken since it mirrors the normal way in which teachers assess most educational resources. No teacher attempts a scientific analysis of text books or filmstrips, he relies on his experience and expertise to judge that which is most likely to best suit both his own teaching style and the constraints of the syllabus. Teachers will of course
apply similar criteria to their analysis of CAL materials. It may of course be argued that teachers have no experience of CAL, which is after all a very different medium from the others. However, teachers are experienced in assessing learning materials per se, and despite inexperience in a new medium basic criteria will remain the same, at least in so far as initial experiments are concerned, a point made by Jones (1987).

Thus it is the subjective opinions of teachers, and to a lesser extent their pupils that is important in software evaluation, however non-scientific and illogical this may appear at times. However, education cannot be measured and analysed like a production line process, however much this approach might appeal to groups such as ITMA and the Centre for Policy Studies. Education is dealing with unique "one-off" products, each of whom reacts in a slightly different way to any stimulus. The ultimate aim may be for all pupils to reach the same end point in terms of achievement but as an objective this cannot be realise. Unlike an industrial process, or indeed the computer itself, a child cannot be "programmed", their achievements are dependent upon innate ability, motivation, and a wide range of personal and environmental factors that defy measurement, although generalisations are usually possible.

There is a problem of course in that there is not necessarily a link between a teachers subjective assessment of good computer programs and good teaching practice. A poor
classroom teacher may be an exceptionally good judge of teaching resources but lack, for example, the classroom control needed to use them effectively, or may simply not be skilled enough to use the resource in an appropriate way. Similarly, some teachers, it could be argued, may use the computer merely for entertainment, as some do with videos when faced with an awkward class. However, the problems of setting up equipment, arranging groups etc are likely to minimise such use. No teacher makes extra work for himself merely to entertain pupils. Further, what is good teaching practice? Katterns and Haigh (1986) note that research over three decades has proved inconclusive and that it does, "not support a single comprehensive theory of learning". They further note that there are not, "generally accepted criteria for judging teachers effectiveness". Such views serve, unfortunately, to muddy the waters still further for it merely confirms that not only is a subjective assessment a personal thing but so is the individual teachers style of teaching. Thus the research seeks a consensus of views rather than taking any one opinion as sacrosanct.

Thus Katterns and Haigh (1986), against such a background, consider that the computer will function as a tool which the teacher will use to enhance and influence learning conditions. These will vary from class to class, even when the same subject matter is being taught; material which works with one group, (or one teacher), may well not be effective with another. Indeed, as Blease (1986) points out:

"... what appears to be a totally uninspiring
program can end up as part of a most stimulating and creative lesson in the right hands."

Therefore it is difficult to state categorically what is good and what is not, other than the end-user in a particular situation. However, it is likely that the consensus noted above will develop as CAL experience increases.

Such views developed early in the writers experience of CAL, which began with the purchase of a Sinclair ZX81 in early 1982, in order to gain some personal experience of the medium in advance of the BBC Micro being available in school. Despite the limitations of such a machine it was immediately obvious that here was a resource with enormous potential, a view that was rapidly consolidated by experience with the early BBC Micros on a number of INSET courses at the local college of higher education. However, one overriding fact became obvious – the software was not only absent but almost no-one seemed to have the faintest idea what form it should take, particularly in secondary schools. Pointers were available in the form of the material produced by the Schools Council Computers in the Curriculum Project (1979), although this was not, at the time, available for BBC machines. However, given that necessity is the mother of invention some initial classroom experiments were conducted using simple programs copied tediously from computer magazines and initially using the ZX81. These proved remarkably successful, since they captured the imagination of pupils who at that time were unfamiliar with computers, and proved a
spur to continue the exercise once the school acquired its own BBC micros and despite the cynicism of most colleagues.

Further experiments ensued and though successful both in motivating pupils and in aiding their understanding the more software that was seen and used so the more questions were raised as to its style, effectiveness and validity. Too much appeared to be lacking in imagination, mechanical in method and failing to capitalise on the inbuilt abilities of the computer such as colour and graphics but more markedly on the innate features of the computer as a tool to aid learning. This early disillusionment led to the submission of a paper to Teaching Geography (Heinrich (1983)) in which an attempt was made to set some form of guidelines for the software publishers from the point of view of the ordinary classroom teacher.

Thus from these early beginnings arose the embryonic concepts leading to this research project. In particular it is based on the feeling that here, in the computer, and despite the limitations of the machines which schools have adopted, lies a most powerful educational tool. That tool however, even when, and if, available in adequate numbers will only prove to be of real benefit if supplied with suitable software. The style and nature of that software together with those areas of geography in which CAL might prove of most use did not, at the time, seem to have been delineated. Thus this project was born.
As previously indicated the decision was made to conduct the research as a blend of both the quantitative and qualitative approaches. However, the quantitative section was limited to the acquisition of data on numbers/types of machines, programs and levels of use. This provided a framework within which the qualitative data concerning teacher attitudes to CAL together with the evaluation of software could take place.

The latter tends towards the phenomenological paradigm in that it is seeking opinions and personal points of view from CAL users. Bogden and Biklen (1982) note that phenomenologists, "believe . . . that it is the meaning of our experiences that constitutes reality". This is appropriate since this paper contends that it is the experience of CAL users that represents the reality of the medium as currently used in our schools. There is a problem in that the use of questionnaires rather than observational methods may force subjects into modes of thinking not in line with their actual approach. Broadly based, open ended questions reduce this difficulty, although care is required in interpretation if the viewpoint of the researcher is not to colour the interpretation of such subjective data.

This approach should contribute to greater understanding of the role and use of CAL from the viewpoint of the end-user and thus be of greater use to teachers than would be the case of the alternative behavioural techniques. A further point must be made that since no two teachers, classes or classroom
situations are the same, and can certainly never be replicated with scientific accuracy then a scientific behavioural study can not be truly valid. The consensus views of a sample of teachers on the other hand, although subjective and dependent on that mysterious phenomenon "professional judgement" are likely to have considerably greater validity. On a practical point also, a behavioural study by its very nature requires considerable classroom observation and is thus very time consuming. A subjective study on the other hand can be largely survey based.

With the above as a main consideration an outline program for the project was drawn up (Fig 3.1) and research instruments constructed in order to obtain relevant data. The programme fell logically into two distinct stages. Initially data would be required concerning the software currently in use together with problems affecting the use of CAL and teacher perception of the role and use of the medium. This to be followed up by the evaluation of a range of software items in order to ascertain any common elements in software that was perceived as successful.

Outline of Methodology

In order to meet the requirements noted above a two stage questionnaire survey was chosen. The initial questionnaire related to hardware availability and access, perceptions of the role of CAL together with a survey of software in current use in the school. Stage two involved an evaluative
Fig 3.1 Research Design

Stage 1

Study of computer use and software availability

Formulation of key hypotheses re CAL usage & nature of software

Stage 2

Evaluation of sample software by teachers

Literature review

Design first Q’naire re CAL usage

Circulate to Hants schools with county Humanities Newsletter

Repeat exercise using direct mailing to HoDs

Q’naire to LEA’s to ascertain levels of CAL usage + names of school contacts

Additional sample - GA Software Review Panel + schools named by LEA’S

Problems:
Time
Finance
Industrial action
Low CAL usage

Analysis of data

Conclusions and recommendations
questionnaire for both teacher and pupils relating to specific items of software. Both questionnaires were trialled by a colleague in a Basingstoke school.

In designing the questionnaires it became necessary to balance the ease of completion and of analysis with the basic requirement to gather the maximum relevant data. Thus techniques such as a weighted scale were felt to be inappropriate for much of the work as was the method of multiple-choice answers. This did have the unfortunate result of the questionnaire being rather long, which fact may have proved off-putting to some possible respondents. However, the initial instrument (Fig 3.2) was drawn up, with, where possible, the respondent ringing an appropriate answer or where necessary providing an answer in prose or note form. To conclude the respondent was requested to provide an inventory of the software that they or their department commonly used.

Section 1 of this instrument gathered basic information to enable the second part of the study to proceed. In addition it asked for information on type and numbers of computers available, although raw numbers may hide access problems, a point expanded in Section 2 where qualification of this matter was asked for. The remainder of the section concentrated upon teacher attitudes to the medium of CAL. In particular it looked for reasons for not using CAL, even amongst those who made regular use. This point is important as difficulties for the uncommitted are likely to prevent
LOUGHBOROUGH UNIVERSITY OF TECHNOLOGY

SURVEY OF SOFTWARE AVAILABILITY IN GEOGRAPHY DEPARTMENTS OF HAMPSHIRE SCHOOLS

TOGETHER WITH REQUEST FOR ASSISTANCE WITH SOFTWARE EVALUATION.

SECTION 1

Name of school: .................................................................
Address: ..............................................................................
Name of respondent: ......................................................... Position: ..............................

Please circle the appropriate answer to the following questions:

1. Are you prepared to assist with the evaluation of software? YES/NO
2. How many packages are you prepared to evaluate? 1-5; 6-10; more than 10
3. How many computers are available for your use? 1-3; 4-6; 6-10; more than 10
4. Make/model of computer available? BBC B; 380Z; 480Z; Spectrum; other (specify)

SECTION 2

Please answer the following questions where appropriate with regard to above answers.

1. If you are NOT currently using CAL please explain your reasons for not doing so.

.........................................................................................
.........................................................................................

2. If you are NOT currently using CAL do you have any firm plans to do so in the near future (ie within the next 2 years) YES/NO

3. If you answered NO to question 2 please explain your reasons.

.........................................................................................
.........................................................................................

4. If you are NOT prepared to assist with software evaluation please give your reasons.

.........................................................................................
.........................................................................................

5. Please identify any specific problems associated with HARDWARE eg access.

.........................................................................................
.........................................................................................

55a
6. Please state briefly how you perceive CAL techniques as a resource in Geography teaching.

........................................................................................................................................
........................................................................................................................................

SECTION 3

Please complete the following table with an inventory of the software that is both available to you and in regular use. If the purpose of a package is unclear from its title please add an explanatory note. For software originated by teachers please state authors name as publisher.

<table>
<thead>
<tr>
<th>Title of package</th>
<th>Publisher</th>
<th>No. of times package has been used</th>
<th>Age range with which normally used</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>9-11 12-13 14-15 15-16 16+</td>
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<td></td>
<td></td>
<td>Other</td>
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</table>

cont/....
Names of additional respondents:

Comments:

Thankyou for completing this questionnaire. If you have offered to evaluate software you will be contacted again at the beginning of the Autumn Term 1985.

Please return completed questionnaires to P J H Heinrich, St George Catholic School, Leaside Way, Swaythling, Southampton.
many from even experimenting. Finally respondents were asked to identify their perceptions of the resource. A wide range of answers were expected and given! Section 3 was used to collect a list of software used together with an indication of the frequency and age ranges with which used.

While the first part of the study forms a simple information gathering exercise the question of evaluation is rather more complicated. MEP, ITMA and others have written widely on the subject, the key text being that produced by ITMA for MEP (Design and Development of Programs as Teaching Material, Burkhardt et al (1984)), which sets out nine stages of development, involving continual evaluation as part of the development process. Many LEAs have produced their own evaluation guidelines and examples of these may be found in Appendix 2. However, the fact remains that as yet we have little experience in this area and that no one approach has proved to be superior to another. As has been stated, it is a basic tenet of this project that it is the teachers "gut reaction" to a program that is important, thus the evaluation pro-forma was designed to get to the heart of these feelings while still providing factual information on the sample software, both as regards its technical merit and its mode of use. The resulting questionnaire would seem to meet these criteria.

This pro-forma (Fig 3.3) was designed to be as simple to complete as possible, important since respondents were asked to complete up to ten of them. Thus for many questions the
LOUGHBOROUGH UNIVERSITY OF TECHNOLOGY

PROGRAM REVIEW PRO-FORMA: TEACHER'S ASSESSMENT SHEET

Assessor ........................................  Date ........................................

School .............................................  Class .....................................

Program details

Name ...............................................  Publisher .................................

Machine: BBC/380Z/480Z/Spectrum/other  Ability: High/Average/Low/Remedial

Media: Disk/Tape

(Previous use of CAL in Geography (approx no of occasions of use):

(Please write in details or delete answers not applicable)

NB The term package refers to a computer program and accompanying documentation.

SECTION 1 - pupil use of package

1. Did pupil interest appear to be

   Above average
   Average
   Low

2. How did pupils cope with the use of the computer itself?

   No problems
   Minor problems
   Major problems

3. How did the pupils cope with the use of this particular package?

   No problems
   Minor problems
   Major problems

Please identify any problems encountered ........................................

4. (a) How much time was spent in preparing the class for the subject of the program?

   0 - 10 minutes
   11 - 20 minutes
   1 lesson (35 min)
   More than 1 lesson in total

(b) How much time was spent on user-training prior to use of the package?

   0 - 5 minutes
   6 - 10 minutes
   11 - 15 minutes
   1 lesson (35 min)
   More than 1 lesson in total

5. How much time did pupils spend on follow up work. (Please indicate in minutes).

   In class .........................
   Other .............................

56a
SECTION 2 - the package

1. Please state briefly what you consider to be the broad aims of the package:

........................................................................................................................................

2. Please identify what you consider to be the specific objectives of the package in terms of the concepts that it claims to teach:

........................................................................................................................................

........................................................................................................................................

........................................................................................................................................

........................................................................................................................................

3. How well do you consider that the program meets these objectives?
   Very well  [ ]  Adequately  [x]  Not at all  [ ]

4. Please identify particular geographical concepts that you consider the package to be most effective in teaching:

........................................................................................................................................

........................................................................................................................................

........................................................................................................................................

........................................................................................................................................

5. Please indicate those aspects of the package that you consider to best promote learning and understanding of the topic taught:

........................................................................................................................................

........................................................................................................................................

........................................................................................................................................

6. (a) How many times have you or your department used this package with your pupils?
   Less than 3  [ ]  4 - 6  [ ]  7 - 9  [ ]  More than 9  [ ]

   (b) How many times has the package been used with this particular class?
   First time  [ ]  1 - 3  [ ]  4 - 6  [ ]  7 - 9  [ ]  More than 9  [ ]

7. Do you consider that use of this package has been most effective with:
   Boys  [ ]  Girls  [ ]  Both  [ ]
   High ability  [ ]  Average ability  [ ]  Low ability  [ ]  Remedial  [ ]  All abilities  [ ]

Comments: ................................................................................................................................

........................................................................................................................................

565
8. (a) In what teaching mode was the package used?  
   Teacher only  
   Teacher/pupil  
   Pupil groups  
   Solo pupil  

(b) Was there a teacher demonstration?  
   Before pupil use  
   After pupil use  
   No demonstration  

(c) Which mode of use do you consider to be most appropriate for this package?  
   Teacher only  
   Teacher/pupil  
   Pupil groups  
   Solo pupil  

9. How much time was required for a typical run?  
   1 - 5 minutes  
   6 - 10 minutes  
   11 - 15 minutes  
   16 - 30 minutes  
   Over 30 minutes  

   If over 30 minutes please specify time.  
   ....................................................  

   Were any problems posed by the run time?  
   ....................................................  

10. (a) With what age range do you think that the package might best be used?  
    10 - 12  
    12 - 14  
    14 - 16  
    16+  
    Other:  

(b) Was the age-range above within the range recommended by the author of the package?  
    Yes  
    No  

(c) Please note any problems encountered if using this package with an age group different to that recommended by the author(s).  
   ........................................................................  
   ........................................................................  
   ........................................................................  

11. (a) Would you recommend the use of this package to other teachers?  
    Yes  
    No  

(b) Please give reasons for your answer to 11.(a):  
   ........................................................................  
   ........................................................................  
   ........................................................................  

SECTION 3 - technical  

1. Did the program load easily and correctly?  
   Yes  
   No  

2. Did the program work as described without apparent 'bugs'?  
   Yes  
   No  

   Please specify particular problems:  
   ........................................................................  
   ........................................................................  

56c
3. Did the program crash due to pupil input errors? Yes  
   No

4. Were graphics clear and an enhancement to the program? Yes  
   No  
   Non graphics

Comments

5. Was the language level of text suitable for the intended age range? Yes  
   No

Comments

6. Was documentation adequate? (a) Teacher Yes  
   No  
   (b) Pupil Yes  
   No

7. Does the package make good use of the capabilities of a computer? Good use  
   Limited use  
   No use

8. Could the material be taught as efficiently by the use of traditional methods? Yes  
   No

Comments

If there are any further comments that you would like to make about the package please do so here:

Comments

Thankyou for completing this questionnaire, your assistance with this research project is greatly appreciated.

Please return completed questionnaires either in the SAE provided or via the internal post system to:  
P J H Heinrich  
Head of Geography  
St George Catholic School  
Leaside Way  
Swaythling  
Southampton  SO2 3DQ
respondent was offered a choice of answers and asked to tick or ring that which was most appropriate. Certain information, eg that regarding perceived aims and objectives again required a longer prose answer.

The introductory section was used to obtain basic program and teaching group details. A minor problem arose in that the question on previous use of CAL, designed to test whether group experience affected CAL use proved too vague. Section 2 concentrated upon pupil use of the program. Key questions here related to the ability of pupils to cope with the package and the time spent on preparation. The intention here being to test the assumption that a CAL package should prove more effective with well prepared pupils. The following section looked for teacher assessment of both the package and its effectiveness. In so doing it avoids the "checklist" approach criticised by Blease (1986), and emphasises the views of the user, a point made by Chambers and Sprecher (1983) who recommended in favour of subjective evaluation based on the professional training and experience of the evaluator.

Thus the questionnaire begins by asking the respondent whether the aims and objectives of the program are clear, since this is considered crucial to effective software and should thus be obvious to the user. If aims and objectives are not apparent then it is likely that the program will be of little use. Similarly, if the package is to prove beneficial then the geographical concepts that it is designed
to teach will be readily apparent. The above should be apparent to even inexperienced users. However, Question 6 concerns itself with the number of times both teacher and pupils have used the program in order to ascertain whether views of a package change with experience. Question 7 is concerned with the effects of gender and ability levels, given that the latter especially will alter the apparent effectiveness of the program.

In order to qualify earlier answers it is necessary to know how the computer was used in the classroom. Thus Question 8 is concerned with the actual mode of use, while Question 10 considers the matter of the age range with which the reviewer considers the program of most value. Such information may be compared and contrasted with the publishers views. Whether a teacher would recommend (or not) the use of a program is of paramount importance, as are the reasons why. This is ascertained by Question 11.

The final part of the questionnaire is concerned with the technical side of the package. Logically a robust, well documented program is essential. Yet many such programs have little educational value whereas in contrast there are programs which are educationally sound but technically poor. This section allows the importance of this area to be assessed.

Pupil evaluation questionnaires (Fig 3.4) followed a similar style and logic. While the option of providing test units
This questionnaire forms part of a research project into CAE and Geography teaching.

Program................................ School.......................... Year/Class.............

Boy/Girl (delete as appropriate)

Please answer the general questions according to your own feelings and opinions of the program. Tick the appropriate box unless told otherwise. Once you have completed this section please attempt the short test exercise.

1. Did you enjoy using this program? 
   - A great deal 
   - No opinion either way 
   - Did not enjoy its use

2. Did you find the program easy to use? 
   - Easy to use 
   - Some problems 
   - Difficult to use

If you found any problems or difficulties please write down what these were:

3. Were instructions and information given on the screen: 
   - Easy to read 
   - Difficult to read

4. Did you find the graphics 
   - Clear, easy to understand 
   - Difficult to understand at times? 
   - Confused and unclear

If you found any difficulties with the graphics please state why:

5. Write down briefly the things that you most liked about the program

6. Write down briefly the things that you least liked about the program

7. Do you have a computer at home? 
   - Yes 
   - No
8. What do you think the program was trying to teach you? ..........................................

9. Do you think that using the computer has helped you with the topic being studied?  
   A great deal □  Of some help □  No real help at all □

10. Please write down any areas of the topic where you found the computer very helpful ..........................................................

11. Did the computer program form a major part of your work on this particular topic?  
   Yes □  No □

12. (a) How was use of the computer organised ie who used it?  
   Individual pupils □  Groups of pupils □  Teacher + pupils □  Teacher only □

   (b) How much 'hands-on' time were pupils able to have?  
   1 - 5 minutes □  6 - 10 minutes □  11 - 15 minutes □  Over 15 minutes □

13. If the computer was used by groups of pupils how big were these groups?  
   1 - 2 only □  3 - 5 □  Over 5 □

14. Were you able to use this package (program) on your own at any time?  
   Yes □  No □

15. Do you think that further use of the program would have helped to improve your understanding of the topic?  
   Yes □  No □

16. Please write down here any further comments that you might like to make about the program.  
   .....................................................................................................................

18. Now that you have completed this general section of the questionnaire please attempt the short test exercise. This may be a short 'multi choice' exercise or may involve a longer written answer. This will depend upon the program that was used. Put the answers on the sheet provided.  
   .....................................................................................................................

Thankyou for completing this questionnaire, your help is greatly appreciated.  
   .....................................................................................................................

Completed questionnaires and test forms should be returned to P J H Heinrich,  
St George Catholic School, Leaside Way, Swaythling, Southampton SO2 3DQ
for each program evaluated was considered this method of testing the effectiveness of pupil learning through CAL was rejected following initial trials. It was considered excessively time consuming for respondents and would stretch their goodwill rather far for very little gain in useful data.

The trials of these research instruments took place at a Basingstoke comprehensive during the Summer Term 1985, thanks to the kind offices of Bob Carr whose own researches in the field of CAL are quoted elsewhere in this paper. The drafts of the questionnaires were modified in the light of this trial, mainly to alleviate any confusing phraseology. In their final form the research instruments met, in so far as is possible, the main objectives of the research intentions and provided sufficient data to enable conclusions to be drawn on the key hypotheses.

In order to locate schools using CAL on a regular basis a further short questionnaire was sent to all LEA geography advisers (Fig 3.5). This confined itself to questions on type and number of computers per secondary school and more importantly the number of schools using CAL on both a regular and casual basis. This latter information allows the size of the sample population subsequently obtained to be set in context.
ADVISORY TEACHER QUESTIONNAIRE

1. Name of contact .................................................. Position .............................................

2. LEA ................................................................. Phone No .......................... Ext ..............

3. Availability of computers in LEA schools
   a) LEA preferred computer
      (Tick box)
      
      BBC B/Master
      RML 380Z
      RML 480Z
      RML Nimbus
      Other (please specify) ................................

   b) Approx. number of computers per school
      1 - 5
      6 - 10
      11 - 15
      16 - 20
      20+

4. Use of CAL in LEA secondary school geography
   a) Number of schools known to make regular use of CAL in geography (ie 2x per month or more)
      0 - 5
      6 - 10
      11 - 15
      16 - 20
      21 - 25
      26 - 30
      30+

   b) Number of schools using CAL on an occasional basis. (ie less than once a month)
      0 - 5
      6 - 10
      11 - 15
      16 - 20
      21 - 25
      25 - 30
      30+

   c) Please list below the names of schools known to be using CAL on a regular basis and who may be contacted for further data.
      1. ........................................................................................................
      2. ........................................................................................................

/ cont
5. Additional comments

Please return completed questionnaires to:
P J H Heinrich, 28 Harrow Down, Badger Farm, Winchester, Hampshire SO22 4LZ
Relationships Between Hypotheses and Objectives

The key hypotheses as previously stated, are concerned with the following:

1. (a) That there are areas of geographical education in which CAL techniques can most appropriately be employed
   (b) The characteristics of software that best promotes effective learning in these areas can be identified

2. Access to hardware is a significant limiting factor in the development of CAL

From this starting point four broad objectives were identified viz:

a) to ascertain and identify the reasons for the current level of CAL usage in Hampshire secondary schools. The intention here was to treat the county as a microcosm of CAL usage throughout the country. In the event low CAL uptake here as elsewhere led to a widening of the net to include schools in a much larger number of LEAs in order to obtain adequate data.

b) to ascertain software that is currently in use in secondary school geography. The data gathered in this part of the exercise relates to the first
hypothesis stated above in that it reveals those areas of geographical education in which CAL is being used, and which must therefore be considered as the most appropriate for the application of CAL techniques on the basis of present usage.

c) for teachers to evaluate selected items of software, in particular those that are in most common use.

d) for pupils to provide evaluative feedback on the same packages.

The latter objectives relate to the second part of the first hypothesis in that the evaluation exercise was designed to yield information concerning aspects of program design and content that are regarded by teachers as being of particular merit in promoting sound learning.

Sources and Means of Obtaining Data

a) The initial questionnaire was circulated to all schools in Hampshire as an appendix to the Humanities Newsletter during the second half of the summer term 1985, together with an endorsement from the Humanities Adviser. Although all 117 secondary schools in the county would have received the questionnaire the response was extremely poor with only some half dozen replies. This poor response may be due in part to the prolonged industrial dispute of the time. However it
also confirms the limited interest in CAL found also by Carr (1985) and concurs with the lack of CAL usage shown subsequently by the survey of LEA Geography Adviser. A decision was made to follow up the Newsletter with individual copies of the questionnaire to all heads of Geography Departments in secondary schools in the county. Again the overall response was limited. In the final analysis a total of 21 replies were received, including middle and tertiary schools (see below) of whom 14 were making active use of CAL in geography. If middle and tertiary elements are eliminated it appears that only 10 secondary schools are using CAL on a regular basis. Since Carr (1985) had found 26 schools experimenting with the medium it would seem that many did not capitalise on early optimism.

b) Given the limited returns from Hampshire it was necessary to widen the sample. As a member of the Geographical Association Software Review Panel, set up to review software and to report upon it for the Associations journal Teaching Geography it became apparent that here, in this group of regular CAL users lay a pool of expertise that might be beneficially tapped. In particular their experience would provide valuable feedback for the evaluative stage of the project and would also indicate the full range of software that is in use. Members of this panel were therefore contacted and provided a further 11 replies. However, it must be accepted that by using such a group no useful data was gained on the general extent of CAL use.
c) Following an invitation to join a group known as the CAL Geography Research Group, organised by Ashley Kent of the University of London Institute of Education, contact was made with a fellow teacher researcher in the field who also offered his assistance.

d) It was realised early on that it might prove necessary to contact selected middle/junior schools plus tertiary colleges in order to assess software that is relevant across nominal age boundaries. In the event these schools selected themselves by replying to the Hampshire questionnaire.

e) As a final stage, and to ensure that the sample included a range of LEAs, schools indicated by the questionnaire to advisers were contacted. The 24 LEAs that replied listed some 65 schools, of which 15 replied to the questionnaire sent subsequently.

Limitations of the Methodology

As is evident from the above the sample from which the data was obtained is quite small. However, it is considered that it is still significant in the light of poor CAL take up in general and in terms of the objectives of this study.

Sample size in relation to CAL take up

The sample is representative of the present situation regarding CAL usage, the small level of which has been noted
by, for example, Ridgeway (1986) and Jones (1987). This is confirmed by response form LEA advisers who indicate that in general less than five schools in each authority were regularly using CAL. If an average of five schools per LEA is assumed this indicates that only about 520 secondary schools in England and Wales regularly use CAL. If non-users are eliminated from the research sample then it may be assumed that on this basis the sample population represents approximately 8% of schools using the resource on a routine basis. Although the rate of development will no doubt be greater in some LEAs the combination of data from both ordinary and experienced CAL users provides in microcosm a picture of teachers use and perception of CAL in Britain today and confirms the limited levels of CAL usage that currently exist.

Sample Size and Software Evaluation

In terms of the evaluation of software the small sample does impose certain limitations. In particular it fails to draw from a sufficiently broad range of experience, relying too heavily on the views of committed CAL users, whose opinions may be at variance with those of the ordinary classroom teacher who does not share their expertise. Thus although the survey enables general conclusions to be drawn on the nature of good software it provides only a vague indication of the range of software in use, though this is of course only a minor part of the whole study. Overall the small sample size is limiting but does not affect the validity of
the findings - they remain significant, especially in view of the similar difficulties and findings of Jones (1987) in a similar study in Hertfordshire.

General Limitations

A number of general limitations became apparent as the project progressed. For example, the nature of non-published software was not always obvious from its title. This was however, an example of a minor problem.

More serious, in the case of the evaluative study were problems relating to the interpretation of the questions, for despite trials such bugs cannot be totally eliminated. With multiple-choice questions there can be little ambiguity but this is not the case with open ended questions. This problem has to be recognised and suitable care taken in the analysis of answers, particularly with pupil responses where language difficulties may lead to confusion. A further difficulty relates to the fact that the control of the evaluation sample rests with the respondent teacher, it being impracticable to do otherwise. Thus a "Monte Carlo" element is present which, though on balance should give a range of responses might tend to be weighted.

A final difficulty arises in that the results are fixed in time. Even were it practical to undertake, for example, telephone interviews with respondents, these would take place some weeks if not months after the evaluation session.
memories fade and indeed further use of the software may have changed the opinion of the user, rendering earlier results negative, although of course such a change in opinion is extremely valid.

However, provided that the results of this study are considered in the light of the perceived limitations the results must be considered to provide a representative view of the current position regarding CAL in secondary school geography.

The Report

The report that follows fall into three distinct sections based upon the results of the three questionnaires. The first stage considers the current position concerning the use of CAL materials in both Hampshire and more generally both from the viewpoint of teacher perception of the medium and from the aspect of the type and nature of the software used. In so doing it attempts to provide a satisfactory answer to both sections of the first hypothesis above.

The second and third sections are concerned with the evaluation of selected items of software by both teachers and pupils. This entails a study of the problems of software evaluation and in particular the difficulties of defining what is good and what is bad, a problem eloquently argued by O'Shea (1985), Chandler (1985) and others. It will be contended that good software displays certain characteristics
in design regarding screen images, curriculum fit, technical merit and ease and flexibility of use. These points will be classified and guidelines for future development drawn up.

While a study of this nature cannot hope to be definitive in its findings it can at least give essential pointers as to future routes. If it is able to do so then it will have succeeded in meeting its original objectives.
The impression is often given in both the press and the popular educational journals that CAL has long since passed the "take-off" point and now forms a major part of the educational experience of most pupils. Minor stories comparing the number of computers in British schools compared with, for example, Japan, give an optimistic impression to the reader, as do TV film clips showing groups of excited pupils clustered around a micro. Journals such as Educational Computing (in its pre-1988 form), with their rather uncritical reviews of each new development do likewise. However, as will be shown, this optimism is not based on fact as far as most schools are concerned.

**The Use of CAL in Geography Departments**

The survey suggests, as does the work of, for example, Ridgeway (1986), Fife-Schaw (1986), Russell (1986) and Jones (1987), that the situation in the majority of schools bears little relation to the optimistic picture often presented. This is well illustrated by reference to Fig 4.1 where returns from almost a quarter of LEAs indicate that in the majority of cases fewer than five schools in each regularly (ie twice a month or more), make use of CAL. Although many more use the medium occasionally (Fig 4.2) this indicates that less than 10% of geography departments have really begun
In most LEA's few schools are regularly using CAL in Geography.
Fig 4.2 Occasional Use of CAL

This indicates that many schools are experimenting with computers.
to develop the use of computers.

A variety of reasons for this dismal picture are presented by the survey, a full summary of which is given in Appendix 1. These relate to problems of hardware access, confused perceptions of the possible role of the computer, software, time and finance. These points will be taken in turn and discussed below.

Teacher Perception of the Role of CAL

Responses to this aspect of the study were almost as diverse as the respondents, even allowing for the small sample, an indication that amongst teachers there is no generally accepted perception of the role that CAL should play. Instead, each individual teacher, with regard to their own unique situation and experiences has developed a different attitude.

Perhaps this is as it should be at this stage in CAL development, for in a medium in which there is as yet no common experience to propagated fixed ideas would undoubtedly prove damaging. The general impression is one of exploration of the possibilities offered, indicative of the state of flux that exists. Eight hostile responses (eg to the request to evaluate materials) demonstrate that even amongst those with an interest in CAL there are already the seeds of rejection. Indeed, given that the majority of geography departments in Hampshire schools failed to respond at all, with only eighteen replies, of which a mere fifteen were from the 117
secondary schools, perhaps indicates that many teachers may already have rejected the approaches inherent in CAL. However, as will be shown, such rejection may be due to rather more fundamental problems than as to a negative perception of the value of the medium.

A key theme to emerge from the study concerns the perception of the computer as a resource. Here it is obvious that those teachers who are actively using it see it in the same light as other audio-visual resources, i.e. as a useful tool with certain specific applications. The following summary of teacher perceptions illustrate this point and further, relate closely to the views of Forer (1983) and Maddison (1984) previously noted. They demonstrate that teachers perceive CAL as:

a) an independent learning tool
b) a resource for enquiry based learning
c) a useful data and text handler and presenter
d) a tool for the introduction of complex ideas
e) a management tool for the teacher
f) an animated blackboard (the respondent noting that this role is for younger children, a view which does seem rather limiting)
g) an aid to learning facts and skills

It is thus obvious that those teachers using CAL do not feel threatened by it but are beginning to visualise a variety of possibilities, particularly in the areas of active and experiential learning. Positive views were expressed by

However, teachers reluctance to answer a lengthy questionnaire or to commit themselves to further lengthy activities during the time of industrial action in the classroom, bears little or no evidence in the actual contents of the questionnaire.
eight respondents as to the benefits of simulations, noting especially the instant response of the computer in an interactive and experimental situation. Such benefits were considered to encourage pupil involvement in the learning process and thus aid both understanding and reasoning. Certainly my personal classroom observations confirm this point.

Some respondents commented upon the power of the computer as a motivator. This may be due in part to its novelty factor but does seem to be especially true for the less able. This type of child was stressed by some, although others noted that extension work with the more able was equally appropriate, especially in a mixed ability situation.

Similarly the use of CAL to reinforce work covered traditionally was stated. Others mentioned the use of CAL for individual and small group work, using simulations and drill and practice type software. Certainly there is a consensus that there are benefits to be gained from group work with computers, particularly since it does seem to encourage participation from children of widely differing abilities, especially where a gaming element is involved. Indeed the author observed this phenomenon in his earliest experiments with CAL.

All respondents, and particularly those with limited experience of CAL seemed content to use it in rather traditional ways. No-one spoke of CAL per se but rather of
an additional tool to be assimilated into existing strategies. Only one response noted the freedom that CAL could engender, eg in allowing greater emphasis on method by reducing content. Such thinking is clearly in line with the new GCSE, where the ability to handle geographical information is of considerable importance. The medium was also perceived as a curriculum extension which could free the teacher within the classroom, presumably to provide more individual help than might otherwise be the case. Strangely only one teacher saw a role for the computer as a management tool for the teacher himself, though this may reflect the limited availability of the necessary hardware.

While the bulk of the responses indicated optimism about the future of CAL, especially amongst those who were regular users, a number of adverse comments were made. Perhaps the most telling were the teachers who noted that traditional methods eg manual versions of games and simulations, could be just as effective as a computer version. Another noted only limited value for the computer due to the poor quality of educational software compared to that available for home micros. It is presumed that this refers to games software with its attractive graphics but whose role is entirely different from that of educational software. It further indicates some confusion on the part of teachers who must be clear about the purpose for which they are using CAL and must make this purpose clear to their pupils also.

Conclusions
It is clear perceptions of the role of CAL vary widely. However, a general consensus is apparent in that teachers take the realistic attitude that the computer is merely another tool to be integrated into their teaching strategies. However, while a number of clear roles have been defined these, particularly as regards the development of new learning strategies are currently limited by a number of factors outside the control of the teacher.

Problems Affecting the Use of CAL in Schools

If a teacher is to make effective use of CAL then he must be motivated to do so, and it is evident that many factors mitigate against such motivation. A number of reasons for not using CAL were offered, relating to both hardware and software.

Access to Hardware

A key area of difficulty relates to access to hardware. Reference to Figs 4.3a and 4.3b indicates that most schools had BBC Micros available, usually as stand-alone machines, together with smaller number of 380Z and 480Z machines. While it might be assumed that stand-alone machines could easily be moved to a geography classroom logistical problems in many schools seem to prevent this. While a few departments possess their own micro most have to fit in with the requirements of Computer Studies and Maths departments.
The dominating position of the BBC (Acorn) machines is clearly shown by this chart.
Again the dominance of the BBC Micro series is clearly shown.
It is clear that many teachers have only limited access to computers, thus limiting the level of classroom use.
Combined figures show that over two thirds of responding schools report problems of access to computers, seriously limiting their use.
Access will remain difficult until more hardware becomes available.
Thus two thirds of responses indicated difficulties in obtaining access to hardware, including one third who had severe difficulties, centring in the main on gaining access to computer rooms timetabled for other courses. Such difficulties were often sufficient to prevent use of CAL. Other respondents noted the difficulty of using a single machine with class groups while networks, where they existed were considered unreliable. (See Figs 4.4a and 4.4b)

In addition to the above the average figure of eight to ten machines per secondary school is obviously restrictive. Unless it is solved the implications for future CAL development are extremely serious. The problems are clearly demonstrated by Fig 4.5 which shows few schools with 15 or more machines available.

Software Considerations
The difficulty of acquiring computer time explains why some respondents indicated that they had had no incentive to use computers or acquire training in their use. Certainly this would appear to be the most significant factor limiting the development of CAL. However, some comments indicated that the nature of the software was also of some importance here.

Comment was made that CAL is as yet in its early stages of development, implying that new, and relatively untried material should be avoided. Others commented upon the simplistic nature of the software available and its supposed inadequacy for the schools (unspecified) requirements. A lack of software was also noted. However, two broad areas of concern relating to software were indicated - funding and
It would appear that many teachers find a lack of time to both find suitable software and to prepare for its use in class, especially where it is being slotted into an existing syllabus structure. Since the review of software and the subsequent planning involved for its successful use is time consuming this does seem to be an important limiting factor. Few teachers are, as yet, familiar with the management techniques needed for CAL use, both in terms of familiarity and confidence with the equipment and software and with classroom organisation. This may be due to a lack of training, which is often of a voluntary nature and undertaken in a teachers own time, there being no systematic on the job training in education as would normally be the case in industry. Undoubtedly many teachers, overloaded by large classes and confused and demoralised by continual tinkering with the curriculum are loath to give up any more of their precious time to a new resource of whose value they are dubious.

However, it must be said that while teachers certainly require basic training in setting up and operating the hardware, (if only to be confident that they cannot break it!), this is not necessarily the case with the software. We are, after all, dealing with relatively simple software, whose operation often involves no more than two or three keys in the case of a typical simulation. The operation of such
software should be obvious to most users who merely need time to explore the educational possibilities of the program. However, where more complicated packages are involved eg databases and spreadsheets a case can be made for more sophisticated training since a much greater depth of understanding of the way in which the program works is required for its successful and beneficial use. This problem requires to be tackled.

Finance
On the point of finance, here is a problem that continually restricts the efforts of many schools to provide an adequate range of software as part of a well resourced curriculum. This has proved a bar to CAL development in many schools. Four respondents quoted lack of finance as the main reason for their failure to develop CAL use. It remains to be seen whether DTI and licensing schemes will have any impact on this problem.

Conclusions
A number of important conclusion may be drawn from the above relating to the low take-up of CAL. Most notable is the difficulty of gaining computer time. However, negative views of the available software together with its cost plus the inherent insecurity of many teachers when faced with unfamiliar technology with which they have no training or experience are also important
Analysis of the Extent and Nature of Software in Current Use

It might be expected that by mid-1986, when this section of the data was collected, that schools would possess wide range of software of good quality which would be in regular use. This is not, however, the case. While the small number of respondents (48) may not be entirely representative of the country as a whole it does represent around 8% of regular CAL users. Half the responses were from regular and experienced users who had built up quite large software libraries, the remainder however had little material available. The latter position seems to pertain even authorities which have positive policies towards CAL, Jones (1987) finding that many Hertfordshire schools only had county issue programs such as QUEST available. However, as noted above, if computer access is not possible then departments will not purchase software.

Number of Programs

A total of 170 programs were indicated as being in regular use. However, this raw figure obscures the true position for many programs appeared only once, i.e., they were used only in the responding school. Only three groups of programs were widely available - the BBC Introducing Geography and Advanced Geography packages, each containing four programs, together with the GA/MEP package of eight programs. In addition many schools possessed a variety of programs originated by the Schools Council Computers in the Curriculum Project, though there was no discernable pattern to their use, individual programs being purchased according to individual curricular requirements. Together these four sources dominate the scene
in so far as geography is concerned.

Classification of Programs

A classification of software has been discussed previously and if this is applied to the items specified by respondents the following breakdown occurs:

Fig 4.6

a) Simulations and games 67 - 39% of total
b) Tutorial/drill & practice 30 - 17% of total
c) Data handling/quantitative 49 - 29% of total
d) Content free/non-specific 2 - 1% of total
e) Text handling 6 - 4% of total
f) Unclassified 18 - 10% of total

Of these programs the vast majority are published material. A small number of programs are authored privately or under development Kent LEA. Only 10 programs were authored by teachers directly, thus confirming the view that the classroom teacher is not a dominant force in software development (Heinrich (1983)), a view opposed by Carr (1984), although there is likely to be a significant input by teachers into any development work by local authorities. Of equal significance is the dominance of the market by a small group of publishers, notably Longman who provide Schools Council material, together with a smaller market penetration by the BBC, Hutchinson, NELCAL and Cambridge/Netherhall. Pure MEP packages have been ignored here since they are not strictly commercial.
Simulations and data handling software dominate the scene in schools.
However, given that the dominant publishers have either taken over material developed by others, especially in the case of Longman and Hutchinson and thus do not have to bear development costs, and, further, are able to finance their software sales from other business, the survey does confirm the findings of the NCC report (1986) regarding the difficulties of small software houses in a small and impecunious market. Given the small level of sales that are indicated for most of the (see Appendix 1) their survival is dubious, yet they may be a better breeding ground for the development of software than the established publishers.

The Nature of Common Software

a) Simulations - general discussion

Analysis of the predominant styles of software when classified reveals a number of interesting trends (Fig 4.6). Of particular note is the predominance of simulations. Given that some programs could not be classified do to inadequate information, and some were undoubtedly simulations then this type of software forms some 40% of that currently used in geography teaching. This would suggest that either teachers find the use of such software of particular benefit or that it is merely an indication of there being more such programs available. As previously noted many respondents perceive simulations as being one of the key benefits of CAL. This concept does seem widely accepted, confirming the views of Chandler (1984) who noted that:

“the exploration of computer based simulations
... may encourage playful thinking, assisting the learner to experiment with hypotheses in a way which can extend ... creativity."

Such experimentation with hypotheses forms a key element of modern geography and has recently been enshrined in the national criteria for GCSE Geography. Even courses with a more traditional structure than say GYSL or Geography 14-18 will, of necessity, have to adopt a hypothesis testing approach to fieldwork. Pupils who have been exposed to such modes of thinking through the use of computer simulations have found the experience advantageous, a point noted by a quarter of respondents.

Unfortunately no data was obtained into the ways in which simulations were actually used in the classroom. While there are obviously occasions when a electronic blackboard mode is indicated this approach does negate the beneficial discussion and thought that is generated by groups of pupils working through program together. Given the problems of hardware access and class sizes it is probable that much work is teacher led, a mode of operation commonly mentioned and one which my own experience indicates to be often the only practicable way of working. This is unfortunate since it tends to negate the discussion and exploration of a problem by the pupils.

Similarly there is no indication of how structured pupil activities are. While some publishers, eg Longman and
Cambridge/Netherhall provide worksheets most do not, leaving the teacher to structure the learning situation. While with many programs worksheets may not be necessary their existence does provide a prop for the teacher insecure with CAL. They can thus prevent the danger that CAL becomes simply a computer game, a reward for the fast worker or to keep the slow worker quiet. As Chandler (1984) notes:

"Computers are more than video-game machines, and it is a betrayal of children for teachers to use them in a way which involves little more thought than pressing a door bell."

This is a problem of which teachers must be aware. Used in an inappropriate manner CAL may not only be ineffective but also damaging in that pupils will develop a low expectation of the medium and respond accordingly.

**Topics in Which Simulations are Used**

It is beneficial at this point to consider those topics in geography in which the use of simulations is well developed. As shown in Fig 4.8 the bulk of commonly used programs cover four main areas of geographical education, viz physical geography, economic geography, agriculture and transport.

Physical geography predominates, comprising 26% of the material. This is perhaps not surprising since while other areas of the subject lend themselves to the more traditional manual games the simulation of physical changes, which in nature are often imperceptibly slow, is much more difficult. The computer has made possible a new approach to the teaching
A general relationship to main curriculum areas appears to exist.
of such subjects since it offers the chance to experiment
with a variety of varying conditions and to test hypotheses
of a "what if..." nature.

Similar comments may be made concerning the use of
simulations in the study of agriculture, settlements and
transport. Given that these form key elements in most
syllabuses it is logical that they should be well catered for
in terms of software. They are also topics where the
planning element involved lends itself to computer
simulation. This is not the case in other areas of the
curriculum, where simulation software is lacking.

Mapwork is one such example, although such a topic does not
necessarily lend itself to the simulation approach other than
through simple games such as SHEEP-DOG TRIAL or as a part of
a larger exercise such as the BBC RIVER. Surprisingly
recreation and leisure has attracted only one program to
date, the rather slow and complicated TOURISM package of
NELCAL. Such an area lends itself to further development as
do for example energy planning and the environmental effects
of different energy policies, the effects of differing
regional economic policies, development along motorway
corridors, and conservation. Unfortunately no publisher has
yet tackled these areas, possibly because such programs would
necessarily be too large for the small memory machines used
in schools. However, we should be looking towards the
development of such software as schools acquire better
hardware.
b) Tutorial or CAI Packages

Approximately one fifth of packages in general use (Fig 4.9) may be considered to be of the tutorial or drill and practice type. However, almost one half of these are specifically for the teaching of OS mapwork. This is to be expected since this form of CAL lends itself readily to the teaching of the mechanical skills of this branch of the subject. A variety of programs were noted although the Cambridge/Netherhall MAPSKILLS 1 & 2 were particularly popular, indicating that well written and trialled software is appreciated by the end users. A total of thirteen such programs were mentioned, mainly originated for MEP, though these were rarely noted more than once, as was also the case with privately authored material.

Other programs concentrated on mapwork in a broader sense and took the form of "spot the city" exercises and quizzes. There were fortunately only eleven of these and they did not appear to be used with any frequency. That teachers have rejected this negative approach is shown also by the appearance of such programs in the lists of home computer software. While there may be a place for such items as WORLDWISE and similar they hardly represent the best use of an expensive resource.

Other areas of in which tutorial CAL has generated some software is in the area of physical geography, notably climate studies. Here the Heinemann program CLIMATE and the
Only mapwork has attracted any quantity of this type of software.
Longman package WEATHER FORECASTING have been adopted by a small number of schools, despite their teaching the subject in a rather dry and didactic way. However, such software does account for about 5% of that available and if representative of the country as a whole does indicate a sizeable number of schools using tutorial CAL methods. The arguments against the CAI approach have already been noted but it is relevant to note the warnings of Chandler (1984) when he notes that:

"children are unlikely to see any advantage in using computers unless they see adults using them in a similar way, and no-one uses drill and practice programs in the "real world"."

However, Chandler's other fear, that most software is of the drill and practice type is patently untrue, as this research has shown. In Geography it accounts for only a small proportion of the available material and is only generally used for the teaching of a single subject area. Perhaps geographers are ahead of the pack but we do not seem to be falling into the traps of which the more cynical observers continue to warn.

c) Data Handling Software

One area where there can be little dispute as to the value of the computer is in data handling. Such programs include specific statistical packages as well as databases and spreadsheets (although some would regard these as "content free"). Programs of this nature accounted for 28% of software in common use (see Fig410).
Many programs of this nature are general purpose and useful anywhere.
It is not surprising that geographers should make wide use of such material for since the quantitative revolution the analysis and interpretation of data has become an essential geographical skill and one that is enshrined in the National Criteria for the GCSE examination. This can require pupils to handle, in classroom situations, relatively large quantities of raw data. The computer is admirably suited to this task as it is also to the manipulation of pre-packaged data. Thus twenty eight programs for statistical calculation were noted, of various origins, they being quite simple to write where the computer is being used purely as a glorified calculator. It is probable that the demands of GCSE will increase the sophistication of such programs in order to ease the burdens of data analysis that pupils will face. Indeed, it is worth noting that those schools reporting frequent use of such software were those with 6th forms. These were also the schools which were developing its use with 16+ candidates.

However, it is in the use of the database program that most future interest would seem to lie. A number of such packages are available, from the simple and bug-ridden WEATHER from Arnold Wheaton, designed for the keeping of simple weather records by primary/middle schools to the full blown and very powerful QUEST/QUERY and INFORM systems. Although at the time of survey only a small number of schools had these latter systems available this is changing rapidly as LEA's negotiate licencing arrangements with publishers. Also a
school per se may own a master copy which is available to, but not the exclusive property of, a geography department. A total of sixteen databases were mentioned including many locally produced programs. Of the remainder GEOBASE, QUEST and KEY were the most common, along with the specialised DEVELOPMENT DATABASE.

An interesting absence from the software lists involved spreadsheets. These were not mentioned at all, perhaps indicating that teachers were not aware of their potential both for modelling and as a tool for handling GCSE grading sheets.

Several respondents noted that they wished to expand their use of these types of software. Indeed, with the new emphasis on IT across the curriculum they will have no choice. However as with so much else in CAL they were prevented from doing so by limited access to computers.

**Content Free Software**

In this analysis of software it is interesting to note that content free/non-specific programs are little used (excluding databases and spreadsheets which are included in the data handling section of this survey). Only two items were mentioned, word processing and the Ladybird EXPLORER package. Despite the benefits of word processing it would seem that such facilities are simply not available in school and if they are then few teachers have shown any interest in making use of them, even for their own benefit yet alone that of their pupils. However, one school did
report the use of both word processors and teletext emulators with pupils. Given adequate access to computers and printers here lies an area ripe for development, and again one that school IT policies must tackle.

In the other case, that of EXPLORER and its companion program INHABITANT we have programs designed for use in English but which, with care and imagination can be used in Geography. However, it is the experience of both the author and other correspondents that such use is both time consuming and requires very careful background work and resource provision if the approach is to be successful. Experience is limited in this area but it is one that is worthy of further work.

**Age Ranges With Which CAL is Used**

It is evident from the content of journals such as Educational Computing, and from discussions with teachers that computer use is regarded as important by primary schools. Similarly the computer has found its way into examination work at both 5th and 6th form level. However, it is now becoming widely accepted that pupils in the lower secondary group are making less than full use of computers in their work. This is to some extent borne out by the data illustrated in Fig 4.11.

This does not bear out the expected high level of computer use in the upper primary age range. However, the tiny sample of schools with such pupils (3), for they fell outside the main area of the target population of the project, is
Fig 4.11 Summary of Prog Type

Physical Settlement Economic Mapwork
Agriculture Transport Population Other

A good range of software is indicated for key curriculum areas.
Fig 4.12 CAL and Age of Pupils

The highest usage continues to be in the upper secondary age groups.
unlikely to be typical and thus no firm conclusions can be drawn in this respect. This is not the case regarding upper secondary schools where the suspected emphasis is proven, thus confirming the views of O'Shea (1985) that lower secondary pupils tend to be denied computer experience.

If, as indicated, this pattern is typical then we are likely to find that pupils entering secondary schools are well used to using computers but are then constrained to work in more traditional ways before being re-introduced to the computer some three years later. No doubt this pattern will change as additional resources become available and as new training schemes and IT policies are developed.

Conclusions
Since the findings discussed above form a discrete section of the whole research project it is beneficial here to reach some conclusions on the data and to consider how they relate to the second, evaluative part of the work.

a) The BBC Micro in its various forms is the dominant machine in school use. Thus it would be beneficial if programs were developed on it rather than on the 380Z and then converted, as often seems to be the case. Thus the full capabilities of the machine could be utilised.

There is at the present time, no evidence that business micros such as the Apple Mac and the many clones of the IBM PC have made any impact on schools. Given that the Amstrad
PC clone is rather cheaper than a BBC Master and considerably more powerful it will prove interesting to see how much longer this position endures. Such clones are also cheaper than the new Archimedes.

b) Teachers have a wide ranging perception of the possible roles of CAL. Although there continues to be some small acceptance of the CAI or programmed learning approach the majority of respondents envisage a far wider role for computing, in particular as a tool for learning rather than as a teaching machine. This role will be accomplished through the use of simulations, modelling and the manipulation of otherwise unwieldy data. However, further developments in these areas will depend upon access to adequate computer hardware.

c) Access to hardware is a major problem for most current users of CAL and a primary cause of the low uptake of CAL.

d) In so far as the type of software in general use is concerned this is dominated by simulations and games, with data handling of rather lesser importance. Tutorial CAL is little used other than for the teaching of the mechanical aspects of OS mapwork.

e) The bulk of the software in general use emanates from a small group of major publishers. Given that they also dominate the market in educational books their products are likely to engender confidence in the purchaser. By virtue of
their size these concerns, with or without MEP or similar subsidies are able to keep the cost of the products to an economic level with regard to school budgets.

f) The research confirms fears that lower secondary pupils are not using CAL to any great extent. This problem may be eliminated as hardware and software resources expand and as teachers receive adequate INSET and guidance. The teams of ESG funded advisers and associated RSA Certificate courses (starting 1988), will go some way to tackling the problem.

Summary
Overall the indications are that CAL has gained little more than a toe-hold in English schools. It is also evident that those teachers who have experimented with its use find it a valuable tool which supports their teaching of the subject. However, it is also clear that some aspects of the medium are more beneficial that others, in particular this applies to data handling and to interactive simulations.

Although a range of software is available and skills in its use and evaluation are developing rapidly less than 10% of teachers seem prepared to use the techniques. Although many reasons for not doing so are indicated, a feeling that the computer offers little advantage over traditional methods was frequently mentioned, it does seem that it is the lack of hardware that is the real key. Software development will stop unless teachers purchase materials. If they have no computers on which to run programs the software will not be purchased and teachers will remain ignorant of its benefits.
If this is indeed the case then CAL will not develop at the pace required by the advances in the economic, industrial and social structures of our society. As Toffler stated in *Future Shock*:

"... our schools face backwards towards a dying system rather than forwards to the emerging new society. Their vast energies are applied to cranking out industrial men - people tooled for survival in a system that will be dead before they are."

(Toffler 1970)

Perhaps this is overstated, but given the importance of geography in enabling pupils to understand the wide ranging relationships between man and his environment, and the lead that geographers have given up till now in the field of educational computing it would indeed be a shame if we now slipped back into complacency. We must look forward to the future, to the electronic environments in which our pupils will live and for which they must be equipped. If we do not then we will have failed in a key element of our task as teachers.
CHAPTER 5

The Evaluation of Educational Software

The rapid growth of CAL since the beginning of the 1980's has led to considerable debate as to the nature of effective software, its identification and evaluation. This debate continues and it is important that this area of difficulty be resolved, for it is crucial to future developments.

The Evaluative Process - a discussion

Essentially evaluation must concern itself with three main issues:

1. The identification of what a program is supposed to actually do.
2. Whether what the program does is actually desirable within the overall educational context.
3. Whether the program is effective in reaching those educational objectives.

There is also of course the crucial question of who should do the evaluating.

With regard to the above Walker (1983) suggests that an evaluative review should, as a prime necessity, "... convey the style of learning for which the unit is designed", and further, that any description of the program, "... should make clear statements about the nature of learning that is likely to take place within the unit. Clearly this is a desirable aim yet as Wellington (1984) reminds us, judging educational software is a personal and subjective activity
and thus open to argument! However, an evaluation based upon the above points, by whatever method it is carried out, should lead to a consensus amongst users.

On the vexed question of who should do the evaluating there are conflicting opinions. O'Shea et al (1985) seem rather dismissive of teachers in the role of evaluators, yet Blease (1986) suggests that it is teachers who are best able to assess the suitability of a program for their own use, a point with which I fully concur. However, it must be accepted that at the present time teachers, despite their general skills in assessing educational materials have only limited experience of CAL upon which to draw. Blease thus goes on to suggest a two stage evaluative process, with an initial stage of "software selection" involving well informed "experts" in educational computing. These make an assessment of a program with reference to commonly agreed criteria on "good educational practice". However, it must be accepted that this cannot mirror the unique situation in every classroom.

That this is a valid approach is confirmed by the opinion of Blease (1986) that true, "... software evaluation is a process performed in schools and classrooms", and this over a prolonged timescale. During this time the program can be adapted into schemes of work and aspects such as learning outcomes and pupil motivation assessed. This is in fact the pattern being adopted by the Hampshire IT Advisory Team, drawing on the experience of classroom teachers in addition
to "expert" opinion and is also the approach adopted by this part of the research project.

The Definition of Good and Bad Software and End-User Perception of the Same

As CAL usage has developed a major debate has erupted concerning the quality of the software available for schools. Certain authorities, in particular O'Shea (1984), Chandler (1984) and Self (1985) have commented at length on this matter. They have concluded that the majority of software is of little use, due to a combination of poor technical quality coupled with attempts to apply unacceptable material and methods to CAL. While this may be true in other subject areas there does not appear to be a major problem with geography.

This does not infer that criticism of some software is not justified. Self (1985) quite rightly takes CLIMATE to task for its poor graphics, pedantic style and failure to fully utilise the inherent facilities of the computer. He further notes that the subject matter is rarely taught in modern geography courses, thus rendering the program irrelevant. It should also be noted that the same material has been taught quite adequately by traditional methods for many years. This general criticism can be levelled at similar materials that do little more than test a pupils ability to use facts rather than to explore new possibilities. Quiz programs such as WORLDWISE, OS QUIZ etc also fall into this category. In so far as technical matters are concerned all would agree that a program which crashes is bad, as is one that is slow, clumsy
to use, or in which colours and graphics are unclear or confusing.

However, it is important that the opinions of authorities who are remote from the chalkface are not allowed to colour the evaluative process. While they may be able to offer detached opinions of great value they are not always fully conversant with the day to day situation in the classroom, which is where the true evaluation process is taking place and where the ultimate decisions on what is good and what bad will be taken.

Modes of Evaluation

Initially all software should undergo formative evaluation as an integral part of its development. Subsequently end users will provide a summative evaluation which requires to be fed back to the authors/publishers in order that any problems encountered with the software may be corrected and the material improved in later editions. Such evaluation is implicit in the GA guidelines for software evaluation (Fig 5.1), for the published views of contributors to journals such as Teaching Geography will provide some guidance to publishers. Similarly, ITMA have developed a system of direct feedback (Fig 5.2) which serves a similar purpose but during the development stage.

It is presumed that most publishers will at least trial their programs, but without careful evaluation such trials may be worthless, particularly if the views of the trial schools are
Figure 5.1 GA Guidelines for Software Evaluation (Teaching Geography June 1983)

**Vital details**
Title.
Supplier - name and address.
Media - tape, disk or cartridge.
Machine - Model and configuration: how much memory is needed, what additional equipment is needed.
Price - and the date when the program was published at that price.

**What it does**
A very brief description of what it does and how it may be used (e.g. interactively by the pupil or as an 'electronic blackboard' by the teacher) and a comment on how well the program works.

**Documentation**
Is it well produced? Is it understandable? Does it:
- Tell you what the program does?
- Tell you where the material fits into the curriculum and what age groups it is suitable for?
- Tell you what background materials are needed?
- Provide materials as part of the documentation?
- Provide references for additional reading, where appropriate?
- Give a running guide to the program with sample data and screen displays to allow you to try out the program?
- Give step by step instructions on how to run the program on your machine?
- Tell you what could go wrong and what to do about it?
- Provide a summary of the instructions on one sheet or card?

**Teaching context**
Where do you think the program will fit into your, or your colleagues' teaching? What age groups does it cater for? What part of the syllabus does it cover? What ability range is it suitable for? Can the material be presented better not using a computer? How long would it take to run? How much preparatory and follow-up work should there be? Does the package cover the ground that it claims to? Publishers and program designers are notoriously optimistic about this aspect of their products.

**Program quality**
a) Does it work?
b) Does it work as described in the documentation?
c) Is the language it uses understandable?
d) Does it use graphics? Does it use them well?
e) Is it helpful if you do not know what to do next?
f) How does it cope with mistakes or stupid input?
g) Can it be listed, amended, copied?

**Conclusions**
Did you like the program? Would you use it? Is it good value for money? Does it have an educational role? Is there anything better to do the job? Do you recommend it?
Fig 5.2

The ITMA model for the program design and development process
(Fraser et al 1981)
ignored or not incorporated into the production versions of the programs, assuming this to be possible within the limitations of memory and the like. Evaluation in fact should be an ongoing feature of software development and should not cease once a program is published, for without evaluative feedback further refinements would not take place with the danger of fossilising development at a rather primitive stage. Evaluation should not only enable us to identify and rectify problems with supposedly poor software, which may be quite sound in its educational concept, but should also help to indicate which particular items of software are effective and why.

Thus from the earliest days of CAL attempts have been made to provide simple evaluative systems both for research purposes and as a means of providing information to teachers. All have met with varying degrees of success.

In many cases the evaluative process is rather limited. At one level there are the MUSE guidelines (Fig 5.3) which seek only to assess the technical merits of a program. At the other extreme lies the complicated objective procedures of ITMA, with a whole gamut of methods in between, many of them of dubious value.

Thomas (1985), for example details the rather ad hoc arrangements of NELCAL and it would appear that these are typical. Still at a basic level, Croft and Evans (1985) attempted to condense their evaluations to a simple star
<table>
<thead>
<tr>
<th>Quality: of information given:</th>
<th>good/fair/poor</th>
<th>good/fair/poor</th>
<th>good/fair/poor</th>
</tr>
</thead>
<tbody>
<tr>
<td>of instruction given:</td>
<td>good/fair/poor</td>
<td>good/fair/poor</td>
<td>good/fair/poor</td>
</tr>
<tr>
<td>of feedback given:</td>
<td>good/fair/poor</td>
<td>good/fair/poor</td>
<td>good/fair/poor</td>
</tr>
</tbody>
</table>
| **-----------------------------------------------------------------------------------------------**
<table>
<thead>
<tr>
<th><strong>Checklist <em>for assessors, answer n/a if necessary</em></strong></th>
<th><strong>ORIGINAL</strong></th>
<th><strong>FINAL</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Numerics: Input Test</td>
<td></td>
<td></td>
</tr>
<tr>
<td>accepts leading +/- digits</td>
<td>yes/no</td>
<td>yes/no</td>
</tr>
<tr>
<td>single decimal point</td>
<td>yes/no</td>
<td>yes/no</td>
</tr>
<tr>
<td>delete/backspace</td>
<td>yes/no</td>
<td>yes/no</td>
</tr>
<tr>
<td>ignores everything else</td>
<td>yes/no</td>
<td>yes/no</td>
</tr>
<tr>
<td>null return ignored</td>
<td>yes/no</td>
<td>yes/no</td>
</tr>
<tr>
<td>terminates with return/enter</td>
<td>yes/no</td>
<td>yes/no</td>
</tr>
<tr>
<td>detects &quot;HELP&quot;</td>
<td>yes/no</td>
<td>yes/no</td>
</tr>
<tr>
<td>detects ctrl-Z and jumps appropriately</td>
<td>yes/no</td>
<td>yes/no</td>
</tr>
<tr>
<td>Commands, Menus, Control</td>
<td></td>
<td></td>
</tr>
<tr>
<td>commands use 3 letter abbreviation</td>
<td>yes/no</td>
<td>yes/no</td>
</tr>
<tr>
<td>menus single key or reason why not appropriate letters</td>
<td>yes/no</td>
<td>yes/no</td>
</tr>
<tr>
<td>0 for go to higher option table</td>
<td>yes/no</td>
<td>yes/no</td>
</tr>
<tr>
<td>return to reveal hidden menu</td>
<td>yes/no</td>
<td>yes/no</td>
</tr>
<tr>
<td>X to exit program</td>
<td>yes/no</td>
<td>yes/no</td>
</tr>
<tr>
<td>escape (or similar) to escape from option or linear section</td>
<td>yes/no</td>
<td>yes/no</td>
</tr>
<tr>
<td>Processing Robustness</td>
<td></td>
<td></td>
</tr>
<tr>
<td>number overflow</td>
<td>ok/error</td>
<td>ok/error</td>
</tr>
<tr>
<td>subscript out of range</td>
<td>ok/error</td>
<td>ok/error</td>
</tr>
<tr>
<td>no string space</td>
<td>ok/error</td>
<td>ok/error</td>
</tr>
<tr>
<td>out of memory</td>
<td>ok/error</td>
<td>ok/error</td>
</tr>
<tr>
<td>argument invalid or out of range</td>
<td>ok/error</td>
<td>ok/error</td>
</tr>
<tr>
<td>subroutine nesting/stacking</td>
<td>ok/error</td>
<td>ok/error</td>
</tr>
<tr>
<td>logic</td>
<td>ok/error</td>
<td>ok/error</td>
</tr>
</tbody>
</table>
| **-----------------------------------------------------------------------------------------------**
| **Suggested minor changes (e.g. screen layout/input)**                               |               |               |
| **-----------------------------------------------------------------------------------------------**
| **Suggested major changes (e.g. options/graphics)**                                  |               |               |
| **-----------------------------------------------------------------------------------------------**
| Remarks                                                                           |               |               |

**Program Assessment Sheet**

**Title of Package:**

**Date:**

**What package does:**

**Potential of Idea:**

1) Suitable for computer presentation? yes/no

2) Potential motivational appeal:   
   visual appeal: good/fair/poor
   ease of use: good/fair/poor

3) Usual mode of use: class demo, teacher/pupil, pupil/teacher

4) Usual age group: 5-9 9-13 13-16 16-19 19+

5) Other materials needed to run program? yes/no

**Program works in 'expert's hands:**

<table>
<thead>
<tr>
<th>Program works in 'expert's hands:</th>
<th>ORIGINAL</th>
<th>FINAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>yes/no</td>
<td>yes/no</td>
<td>yes/no</td>
</tr>
</tbody>
</table>

**Program contains default settings:**

<table>
<thead>
<tr>
<th>Program contains default settings:</th>
<th>ORIGINAL</th>
<th>FINAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>yes/no</td>
<td>yes/no</td>
<td>yes/no</td>
</tr>
</tbody>
</table>

**Robustness:**

<table>
<thead>
<tr>
<th>Input: good/fair/poor</th>
<th>good/fair/poor</th>
<th>good/fair/poor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output: good/fair/poor</td>
<td>good/fair/poor</td>
<td>good/fair/poor</td>
</tr>
<tr>
<td>Processing: good/fair/poor</td>
<td>good/fair/poor</td>
<td>good/fair/poor</td>
</tr>
<tr>
<td>Peripherals: good/fair/poor</td>
<td>good/fair/poor</td>
<td>good/fair/poor</td>
</tr>
</tbody>
</table>

**User Interaction appropriately chosen?**

| yes/no | yes/no |

**Controllability of Package:**

<table>
<thead>
<tr>
<th>Internal instructions: good/fair/poor</th>
<th>good/fair/poor</th>
<th>good/fair/poor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internal help: good/fair/poor</td>
<td>good/fair/poor</td>
<td>good/fair/poor</td>
</tr>
<tr>
<td>Error messages: good/fair/poor</td>
<td>good/fair/poor</td>
<td>good/fair/poor</td>
</tr>
<tr>
<td>Pause and Timing: good/fair/poor</td>
<td>good/fair/poor</td>
<td>good/fair/poor</td>
</tr>
</tbody>
</table>

**Program Structure:**

<table>
<thead>
<tr>
<th>Modular construction: yes/no</th>
<th>yes/no</th>
</tr>
</thead>
<tbody>
<tr>
<td>Header module: yes/no</td>
<td>yes/no</td>
</tr>
<tr>
<td>System initialisation module: yes/no</td>
<td>yes/no</td>
</tr>
<tr>
<td>Program initialisation module: yes/no</td>
<td>yes/no</td>
</tr>
<tr>
<td>Control module: yes/no</td>
<td>yes/no</td>
</tr>
<tr>
<td>Machine parameters as variables: yes/no</td>
<td>yes/no</td>
</tr>
<tr>
<td>Task/poke/call/machine code: none/some/many</td>
<td>none/some/many</td>
</tr>
</tbody>
</table>

**Screen Layout:**

<table>
<thead>
<tr>
<th>Information (text): good/fair/poor</th>
<th>good/fair/poor</th>
<th>good/fair/poor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input: good/fair/poor</td>
<td>good/fair/poor</td>
<td>good/fair/poor</td>
</tr>
<tr>
<td>Messages: good/fair/poor</td>
<td>good/fair/poor</td>
<td>good/fair/poor</td>
</tr>
<tr>
<td>Tables: good/fair/poor</td>
<td>good/fair/poor</td>
<td>good/fair/poor</td>
</tr>
<tr>
<td>Diagrams: good/fair/poor</td>
<td>good/fair/poor</td>
<td>good/fair/poor</td>
</tr>
</tbody>
</table>

**Fig. 5.3 MUSE guidelines and program evaluation pro-forma**
rating. While acknowledging that this was meant to be only a basic guide the criteria upon which it was based were limited to an analysis of presentation, robustness, use of computer facilities, quality of support materials and cost. While these are relevant so to are points concerning objectives, accuracy of models etc which are apparently ignored. Thus such a system does not meet the key points made at the beginning of this chapter.

Wellington (1984) similarly attempted to set out a checklist for the evaluative process. This comprised sections on technical and practical criteria together with an analysis of teacher and pupil reaction to a program, and its educational value. Blease (1986) notes many such checklists and examples of those used by LEA's and which have been well documented by Thomas (1985), are appended to this paper. It may be seen that these are broadly similar in character. Most require data on mode of use, relevance of the material and pupil reaction/interaction with it, documentation and technical aspects. However, a number of important points would appear to be overlooked. For example there is no comparison of the perceived objectives of the package to the stated objectives, nor are evaluators required to assess the particular geographical concepts that the material might teach. Furthermore that fundamental question of whether the same material might be taught as effectively by traditional methods is overlooked. This last point is most relevant since there seems little point in using CAL, with its inherent extra preparation load on the teacher when
it shows no real advantage. One must return to the experience of the individual teacher in this matter. As Nash and Ball (1982) state on this point:

"... the most important guide you will have to the effectiveness of the computer in your teaching is your own instinctive feeling about it. ... in the end we are probably guided by one consideration only - whether we feel that it worked".

To this might be added the question as to whether the pupils thought that it worked.

Blease is however, critical of this approach, considering that the selection criteria may not be appropriate to a particular program or program type. Similar points are made by Chambers and Sprecher (1983). However, it is contended that a carefully designed checklist, which allows fully for open ended answers from the evaluator remains one of the best means of tackling the evaluation problem.

In contrast to the subjective methods considered above there is also the traditional objective approach. Here, two main quantitative methods have been developed. These being the SCAN system developed by ITMA (Burkhill 1983) and a rather complicated system developed by Sakomoto et al (1979) as part of the PLATO project.

ITMA is primarily a research group with its main interests in the area of primary education and goes to quite extraordinary lengths to trial its programs. Indeed, Self (1985) comments
that some would regard their trials as excessively thorough. Their Scan system -Systematic Classroom Analysis Notation does indeed appear very complicated. This, however, forms only a part of a series of studies involving teacher comment, pupil work, pupil interviews and observation of lessons. Fraser (1983) notes that it has proved extremely valuable. Logically, software developed by such methods should be of high quality yet the one geography program developed through the project, TRANSPOTS, appeared only once in the survey of software. Indeed, it could be criticised for its poor graphics and limited relevance to curricular needs! Thus it is contended that such in depth testing does not necessarily provide the desired results.

However, O'Shea and Self (1983), while noting that this and similar approaches are most likely to convince sceptics and decision makers, remain critical of the results thus obtained. They raise the point that since CAL is concerned with adding new skills or knowledge to instruction new methods of evaluation are required. They go on to stress that:

"We have rejected the view of learning as a gradual, "statistical" process and are bound to reject statistical evaluations; we have emphasised learning as an individually based activity and are bound to look at individuals for evidence."

This serves to confirm the view that it is the opinions of the end users, ie the teachers and pupils that are crucial to
the whole evaluative process and that a true assessment must involve the synthesis of the views of a representative sample of this population.

Indeed the real evaluation of a program must take place under classroom conditions. However, it must also be accepted that this will be largely subjective and unquantifiable, as with so much in education. It will however, have the validity borne of experience.

Conclusion
Ultimately those whose involvement in the evaluative process is as a consumer who has a choice to make should perhaps, follow the advice of Nash and Ball (1982) who consider that one should, "look at everything critically", ie that the rose coloured spectacles apparently worn by the reviewers in some journals should be discarded. They go on to suggest that there is a need for a three stage evaluation process:

a) Before a program is used
b) before purchase of your own copy
c) After you have used it for a while

There is little to argue with in this approach, for as has already been intimated, long term evaluation is likely to prove of considerable benefit.

Thus it may be concluded that the evaluation of educational software is fraught with difficulty. There is as yet no real consensus as to the form that it should take, although the role of the teacher as the primary source is gaining ground.
This debate will no doubt continue for some considerable time to come and it is against this background that the evaluation exercise documented in the next chapter must be set.
CHAPTER 6

Results of an Exercise in Software Evaluation

It has been contended that software which promotes effective learning in Geography will exhibit particular identifiable characteristics. In order to ascertain that this is indeed so it was necessary to carry out an evaluation of a sample of software in common use, this having been identified by the initial survey detailed earlier.

As noted in the previous chapter it is considered that teachers are the best judges of effectiveness under classroom conditions. This a questionnaire survey was used to gain their views on the sample items. The exercise used the pro-forma described and explained in Chapter 3. It is a synthesis of other evaluative instruments, modified to include the points discussed previously.

The survey was limited to some 28 programs, all evaluated by teachers with some experience of CAL, (Fig 6.1). The authors own observations are interjected where appropriate with regard to software of which he also has classroom experience.

Teacher Perception of Sample Programs

The research does tend to confirm the view that perceptions vary with experience of CAL. For example, note comments on SAXONS, a simple settlement game, teacher originated and published as an MEP Blue File. Most evaluators found it useful, noting for example that:
### Programs used in evaluation exercise

<table>
<thead>
<tr>
<th>Program</th>
<th>Publisher</th>
</tr>
</thead>
<tbody>
<tr>
<td>Summit</td>
<td>BBC</td>
</tr>
<tr>
<td>River</td>
<td>BBC</td>
</tr>
<tr>
<td>Flight</td>
<td>BBC</td>
</tr>
<tr>
<td>Swindon</td>
<td>BBC</td>
</tr>
<tr>
<td>Salford</td>
<td>BBC</td>
</tr>
<tr>
<td>Leicester</td>
<td>BBC</td>
</tr>
<tr>
<td>Map-skills 1</td>
<td>Camb/Netherhall</td>
</tr>
<tr>
<td>Map-skills 2</td>
<td>Camb/Netherhall</td>
</tr>
<tr>
<td>Sea-Cliff Erosion</td>
<td>Camb/Netherhall</td>
</tr>
<tr>
<td>Farm</td>
<td>Longman</td>
</tr>
<tr>
<td>M-Way Route</td>
<td>Longman</td>
</tr>
<tr>
<td>Urban Growth</td>
<td>Longman</td>
</tr>
<tr>
<td>Tourism</td>
<td>NELCAL</td>
</tr>
<tr>
<td>Micro-mapping</td>
<td>NELCAL</td>
</tr>
<tr>
<td>Census Data Base</td>
<td>NELCAL</td>
</tr>
<tr>
<td>Slick</td>
<td>BP</td>
</tr>
<tr>
<td>Transport Network</td>
<td>GA/Hutchinson</td>
</tr>
<tr>
<td>Water Budget</td>
<td>GA/Hutchinson</td>
</tr>
<tr>
<td>Ice</td>
<td>GA/Hutchinson*</td>
</tr>
<tr>
<td>Solar</td>
<td>GA/Hutchinson*</td>
</tr>
<tr>
<td>Nomsim</td>
<td>Listing</td>
</tr>
<tr>
<td>Saxons</td>
<td>MEP BLUE 34</td>
</tr>
<tr>
<td>Quest</td>
<td>AUCBE</td>
</tr>
<tr>
<td>Bearings</td>
<td>Acornsoft</td>
</tr>
<tr>
<td>OS Quiz</td>
<td>Acornsoft</td>
</tr>
<tr>
<td>Locks</td>
<td>Public domain</td>
</tr>
<tr>
<td>Ecosoft</td>
<td>CEE</td>
</tr>
</tbody>
</table>
"It does provide a different approach . . . and attracted pupils attention."

This same respondent also noted however that the graphics are very slow and that pupils commented adversely on their primitive nature. Another respondent with little CAL experience noted the lack of flexibility of the program and went on to state that:

"... it did not really explore the potential of the computer beyond that of a glorified worksheet . . . use of the computer was more of an incentive to the pupils than the actual programs."

Despite these criticisms both respondents would recommend the program to other teachers. A noteworthy point is that although aware of the negative elements of the software, including its poor technical quality, they perceived valid uses for it, either as an introduction or conclusion to the topic or simply as a motivational tool, indicating that the educational concept of the program is sound.

In comparison with the GA/MEP program SETTLEMENTS, which covers the same material, SAXONS is primitive. The author has used both in the classroom on many occasions and found them both effective when used with the right class and suitable back-up material. In this context SETTLEMENTS proves a much more complicated program to use since it requires greater class preparation, worksheets and technical skill from the pupils eg with coordinates. Yet technically and educationally SETTLEMENTS is the superior program, making better use of the computers facilities. However, another
respondent noted that this and other GA/MEP programs were:
"... considered too complex, or, without having a colour monitor, unclear."

if nothing else the above serves to demonstrate that teacher perception is indeed a fickle animal.

Similar difficulty is encountered with other examples. The GA/MEP TRANSPORT NETWORKS is noted as interesting but of no more help than ordinary classwork and is not recommended. yet the program was developed by experienced teachers and was well trialled. However, the respondent was clearly unsure of how to integrate the program into her teaching, a factor which may have coloured her opinion.

In the teaching of mapwork this problem should not occur. A number of packages exist in this area, notably MAPSKILLS 1 and 2. The author has found these very useful but must agree with those who consider the GRIDREF program to be "less than dynamic"; a pupil is quoted as describing it as "like a boring textbook". Despite such an indictment the respondent goes on to recommend the program. even though further criticisms of the graphics and lack of colour are made, together with comments on the amount of text on the screen. However, in the case of MAPSKILLS 2 the blunt comment is made that it is a "very tedious program" and not recommended. It is clear also that its complexity and the amount of time required to use it render it of little real value. The NELCAL package MICRO-MAPPING serves a similar role and receives an equally blunt comment, "it works!".
There is also the question of how perceptions of a particular program may vary as the users experience of it develops. While the study did not address itself directly to this matter the following example serves to indicate that this aspect of evaluation deserves further study. The program in this case was EXPLORER, a part of the Ladybird-Longman "Other Worlds" package, which although an English package has applications in geography. Having evaluated the program for Teaching Geography it was lent to a colleague for a more extensive trial. Although initially impressed she became disillusioned by, in particular, the problem of providing an adequate range of stimulus material and also of motivating pupils within the rather rigid structure of the program. While only one example and therefore not necessarily significant it serves to show that evaluation should be an ongoing process and that experience of a particular program is as important as experience of CAL per se.

Many other cases could be considered, but it becomes clear that while perceptions can and do vary, a number of points are clear from the above. In particular teachers seem to perceive as good that material which has both as obvious purpose and a curriculum fit. Technical problems are of less significance though these are commented upon in a detrimental manner eg. the monochrome graphics of GRIDREF detract from its appeal but do not affect its educational value. Similarly, the technically poor and untrialled NOMSIM (a teacher originated Fulani nomad simulation) is perceived as
useful since it fits a commonly taught part of the curriculum.

Ultimately, and leaving aside technical quality, there are two questions which decide whether a program is "good" or "bad", does it work and does it fit a curricular need. The latter is easy to assess but the former is more complicated, for what actually makes it work? Well trialled software should "work" in the technical sense and also in the sense that it is effective in teaching that which it purports to teach, yet it is obvious that this is not always the case with all people.

Thus it must be concluded that perception is something of a minefield. Although it plays an important part in an evaluators judgement there are more concrete aspects of a program that can be assessed. There also remains the problem that in a survey of this nature it is not possible to be sure of a respondents intentions or objectives in using a particular program with a particular class on a particular occasion. This could perhaps be considered a weakness in the research design. However, a teachers objectives and intentions change in a variety of ways according to a particular situation and according to his experience of the software. Thus the research instruments looked for an overall perception of a program rather than the results on a particular occasion and it is within these parameters that the above must be considered.
The Technical Aspects of Software

1. Introduction

Of prime importance to the user is the requirement that a program should LOAD and RUN without any problems. In use it should also be robust and capable of dealing with the keying errors of inexperienced users without crashing, be free of bugs and should make full use of the computers' graphics and other abilities. Given the wealth of programming experience and the fact that most educational programs are very short by commercial standards there seems little excuse for material that fails to reach such minimal standards.

Of the programs evaluated no fundamental problems were encountered. All loaded correctly and easily from disk, though tape versions were no doubt subject to the usual horrors that afflict this medium. Similarly the vast majority of programs were mercifully free from obvious bugs. Where these were apparent, as with spelling errors in NOMSIM they were usually of little consequence. However, in the case of SOLAR, which would not accept 0 degrees latitude or 0 oktas cloud cover, the user is entitled to feel a little irritated. Similarly with parts of the otherwise excellent GENERAL MAP READING where bugs prevent the user from following some correct routes. Such errors should have been eliminated during trials. The most serious problem to afflict a program is a tendency to crash, either do to an inherent programming fault or to an operator error. This
does not seem to be a problem with most modern programs, unless BREAK has not been disabled. Curiously, most problems were reported with the BBC Introducing Geography package. From personal experience, something confirmed by other teachers, the usual cause of such problems in class is the bored pupil who wishes to see what will happen if . . . . For this there is often no protection good enough!

2. Graphics

It is the quality or otherwise of graphics which tends to provoke the most comment, both good and bad. This is not surprising since many people are used to the high quality graphics of many home computer games and are sometimes surprised at their rather poor quality in educational programs, though pupils are perhaps more critical than teachers.

A common criticism concerned the failure to fully utilise colour eg in MAPSKILLS 1 and 2 and in TRANSPORT NETWORKS. Other programs were considered to use poor colour combinations, thus causing confusion as in CENSUS DATA BASE and SOLAR. In the latter case, with a rather complicated screen display the method of showing the energy flows was not clear, although it must be noted that an unpublished trial version was being used. Given the work of Alderson and DeWolf (1984) in this field (see Figs 6.2 and 6.3) there should be no reason for problems with future software provided that programmers take note of these findings. In other cases excessive graphics were used as in NOMSIM, or not used fully
The above figure demonstrates that if both background and foreground colours are chosen from the same part of the scale legibility will be limited. It indicates the need for careful consideration of colour during software design.
Figure 6.3

<table>
<thead>
<tr>
<th>Background Colour</th>
<th>White</th>
<th>Yellow</th>
<th>Cyan</th>
<th>Green</th>
<th>Magenta</th>
<th>Red</th>
<th>Blue</th>
<th>Black</th>
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<td>✓</td>
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<td>Cyan</td>
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<td>✓</td>
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</tr>
</tbody>
</table>

This table shows the colour pairings which give good and poor legibility on both colour and monochrome screens.

Ticks (✓) are RECOMMENDED pairings.
Crosses (×) are pairings to AVOID.

After
Alderson and DeWolf (1984)
as in SWINDON where it was noted that a flow diagram might have proven beneficial. Graphics screens which were slow to draw were not welcomed eg, with SAXONS and SLICK, nor was the use of TELETEXT style graphics in most cases. although these are well used in GENERAL MAP READING. High quality graphics such as in SEA-CLIFF EROSION, SUMMIT, RIVER and ICE were commented upon favourably, indicating the positive impact that good use of this feature has on the acceptability of a program, even of SEA-CLIFF EROSION where the program content is conceptually unsound! The clear, simple graphics of SEA-CLIFF EROSION are shown in Fig 6.4.

However, a small note of caution needs to be sounded. Certain early programs from the Computers in the Curriculum project, which were originally text only, are now becoming available in graphics versions. Yet has the educational value of the programs improved as a result?

Given that in the case of say FARM the run time is now greatly increased due to graphics which do little more than replace a worksheet the answer would appear to be no. An extra 2 - 3 minutes run time per pupil/group per session plays havoc with lesson timing and would in some circumstances seem to reduce the value of an otherwise useful program. It would seem unwise to use graphics merely as a gimmick - to be beneficial they must enhance the educational value of a program.

3. Text and Documentation

A further area of concern arises regarding documentation and
Fig 6.4 Sample screens from SEA-CLIFF EROSION demonstrating the nature of the graphics.
language levels. In so far as language levels on the screen are concerned there seems to be little problem, though the use of unfamiliar technical terms in CLIMATE was noted, as was a surfeit of text screens in MAPSKILLS 1.

A key concern amongst evaluators centred upon the poor quality of documentation, particularly for pupils. The GA/MEP package is heavily criticised on this point, for while teacher documentation is excellent that for pupils is limited to a simple description of how to operate the program. It would seem that teachers appreciate worksheets such as those provided with the Cambridge/Netherhall materials, even if these are used only as a guide for teachers to develop their own. In the case of CENSUS DATA BASE it was noted that "more could be provided", while that for CLIMATE was described as "difficult".

Perhaps with this new medium teachers are rather insecure and need the prop of worksheets and the like provided in order to increase their confidence in the use of CAL. However, it must be accepted that the mode of use of much software is so open that to prescribe work is not possible, though this should not prevent guidelines being given.

4. Use of Computer Capabilities
Finally evaluators were asked to give their opinions of how well the program used the capabilities of the computer. Interestingly most did, although a few seemed to act as little more than electronic page turners. Of more importance
to the exercise are those which make only limited use of the machine capabilities, such as NOMSIM and SAXONS and where a manual game could perform the task equally as well. Programs which might be expected to make fuller use of the computers capabilities but in the view of evaluators failed to do so include SWINDON, DERWENT and TRANSPORT NETWORKS. Again respondents felt that the topics covered by this software could equally well be taught by traditional, if time consuming methods.

There appeared to be a feeling that merely replacing the traditional by a computer was not good enough. However, it is possible to transfer a good manual game to a computer with beneficial results. For example, SLICK, a popular environmental studies board game has been well received in its computer version, a respondent noting that the material could not be taught as efficiently by traditional methods.

5. Conclusions

The above confirms that technical aspects of a program, while not of over-riding consequence to a teachers perception of the educational value of a program are important. A number of points and issues have been raised in the above analysis and it is beneficial if the key points relating to the technical features of "good" programs are summarised at this point:

a) Loads easily
b) Free from bugs
c) Crashproof in so far as this is possible
d) Graphics used to enhance the program and not
merely as a gimmick

e) Colour is essential but colours must be chosen carefully with regard to screen visibility

f) Language levels appropriate to the intended age group and allowing for the disparity in reading skills that such a raw chronological datum might overlook.

g) Documentation clear and concise for both teacher and pupil. The provision of example worksheets for pupils is essential at the present time

h) The "good" program makes full use of the computers unique capabilities viz.

i) Rapid manipulation of data

ii) Flexibility of response

iii) The use of graphics

iv) Randomisation

v) The ability to handle complex simulations

Such programs do not merely work as an electronic version of a traditional exercise - they are interactive and demand more of a pupil than merely pressing keys.

The above broadly agrees with the findings of Thomas (1985) and go some way to meeting the criticisms of O'Shea (1984 and 1985) as regards technical quality of programs. This will no doubt continue to improve with time, indeed the latest programs from Longman are much more professional in appearance. However, such materials may prove expensive and thus not considered commercially worthwhile as indicated by the NCC report (1986). Only when the end user demands
programs of a professional quality and is prepared, (or able) to pay the price will this take place. Yet school software is beginning to look overpriced in comparison with that available for eg PC compatibles. New software must not only harness the power of new machines such as the Nimbus and Archimedes but must do so at a reasonable cost and to high standards. Only then will the more cynical members of the teaching profession develop the use of the computer to its full extent.

The Relevance of the Computer Experience of Teacher and Pupil

While many pupils are conversant with computers as games machines such experience does not infer that they are able to handle educational programs without some user training. The same is true of the average teacher. Fortunately few programs require a high level of keyboarding skills, nor is any knowledge of programming required, only the ability to plug in the computer and peripherals and load a program. However, if the user is confident with the machine he is likely to pay greater attention to educational value of the software as will also be the case of he can drive the program without constant reference to the manual.

It is logical to surmise that the technical skill, in terms of the computer experience of teacher and pupils will affect attitudes to any particular program. Indeed, it is probable that some packages require a certain amount of expertise in their use and are thus not suited to the inexperienced user. Changing perception of a program over time has already been
Technical skill is difficult to quantify in a limited survey of this type for given the large variety of classes there will obviously be widely disparate computer skills, ranging from the erstwhile "hacker" to the pupil who encounters the machine for the first time. However, given that most CAL lessons tend to be organised on a group basis there is likely to be one pupil with experience in each. Certainly few problems with the actual use of the computer were reported and these only of a minor nature and with classes using the machine for the first time. Problems that did occur centred more upon various aspects of the programs themselves.

For example, in the case of FLIGHT, a frequent need to refer to instructions interrupted progress, while the evaluator of ECOSOFT noted that pupils required detailed knowledge prior to the CAL session and that, "extensive familiarity (was) needed". However, few programs have had extensive use. Only teachers with broad experience of CAL had used any program nine or more times with a class. Thus experience of problems was limited. Indeed, in some cases the evaluation material was being use with a class for the first time. Thus few sound conclusion can be drawn.

However, there remains the matter of the lack of teacher expertise in information technology. Currently only those teachers with an interest in CAL have received any form of INSET, usually in their own time and often at their own
expense. Equally, those with experience often have only a limited range of software upon which to draw, thus limiting their experience here also. It would seem that if CAL is to develop fully there is a distinct need for more training. Whether this takes place via LEA originated courses, those instigated by colleges or simply within a school is irrelevant - the key requirement is that teachers become as familiar with computers as they are with chalkboards and videos. If this is matched with the provision of software libraries and licensing arrangements by local authorities as now seems to be happening then it will be possible for experience to grow and with it a more critical and valuable evaluation of the software, which will further aid development.

The Role and Importance of Class Preparation
Two issues must be considered here. Firstly, preparation involves the teacher in bringing pupils to the stage in a course where it is beneficial to introduce the computer, ie they have adequate background knowledge. Secondly there arises the question of preparation for use of the computer itself in terms of driving the program and of handling any documentation.

These are of course variables, dependent on factors as disparate as previous class knowledge of a topic and whether the CAL session are to be used as an introduction, for reinforcement or as a conclusion. The amount of preparation time reported by respondents varied enormously, from a lesson
or more for TOURISM and SEA-CLIFF EROSION to a few minutes for mapwork programs. Thus no firm conclusion can be inferred since it is ultimately down to the judgement of the individual teacher as to how the CAL material fits into his particular scheme of work.

Of more significance is the time spent on "user training", i.e. teaching the pupils to drive the program. In the case of simple programs less than five minutes proved typical, and certainly personal experience indicates that little more is usually required. However, with more complicated material such as databases, or complicated simulations such as SLICK, far more time is needed. Respondents using these programs often spent an hour or more familiarising their pupils with the program, an indication that this is essential if pupils are to gain full value from the work, i.e. for the CAL experience to be effective. Certainly where an evaluator failed to allow sufficient time, e.g. with SWINDON and DERWENT where he allowed a mere five minutes, he was subsequently unimpressed by the value of the program. Given more experience on the part of the teacher and fuller training for the pupils the end result may well have been different.

Thus there would seem to be a positive indication that there is a relationship between the effectiveness of CAL and the time spent in preparing for the CAL session. As with much else in teaching it is the preparation that counts.

The Effect of Gender and Ability
It is widely accepted that boys have considerably more general experience of computers, via the use of home computers for games playing than do girls. Furthermore it would seem that computers are often seen as a boys interest, possibly do to their misguided association with maths and science.

However, in the classroom situation there seems little evidence that gender is a relevant factor in CAL usage. Interestingly female respondents tended to find that boys respondent better, particularly in the case of a middle school. It is probable that an element of teacher expectation is evident here. This is inconclusive, but indicates that the attitude of teachers to pupil gender is perhaps more important than software when considering the effect of gender on CAL.

Of greater significance is the ability level at which the program is aimed, and it is here that the teacher must exercise careful judgement, not only in his choice of software but also in the way he introduces it and the additional learning materials that he provides. An insight into the problem is given by the respondent, referring to TOURISM, who states that, "different abilities get different things from the package", although he fails to specify what these are. Regarding the same package a further comment noted that age and computer experience, together with the time available for use were equally of importance due to the complexities of the program. Similarly with M-WAY ROUTE
where pupils of average and below average abilities were noted as having conceptual difficulties with the material.

However, with other packages teachers who provided their own worksheets, geared to particular abilities, found fewer problems, although SEA-CLIFF EROSION and MAPSKILLS 1 were noted by some as being too complicated for remedial pupils, something with which I would not agree. MICRO-MAPPING (DIRECT) was considered to create problems for children with reading difficulties, while a respondent who rejected the complexity of many program in the GA/MEP pack noted that WATER BUDGET was useful once suitable worksheets had been provided for the less able. However, QUEST, a quite complex database, was indicated as being usable with all abilities given suitable structuring of the work. Meanwhile pupils using ICE were described as being, "... totally absorbed in (the) program from least to most able in (the) group."

Thus it may be concluded that while gender is not of great significance in software design consideration must be given to the ability and conceptual level of the pupils who will use the program. While many teachers are able to use some programs across a wide ability range this does not appear to be general and many programs are not generally accepted as necessarily suitable for the age range intended by the designers. However, a key element does seem to involve the teachers willingness to experiment and to design suitable additional resource material. Such comments are not, of course, unique to CAL and the way in which the medium is
The 'gatekeeper' model
The teacher sees the computer as his personal preserve, access by students carefully controlled and monitored.

b) The 'barrier' model
The teacher uses the computer to insulate himself from student contact.

c) The 'diversionary' model
The computer diverts student attention away from a course or teacher.

d) The 'partnership' model
The computer is a 'partner' to both student and teacher. The student's learning is aided by both human and computer interaction, teacher and student explore concepts and ideas together.
Fig 6.6 Whole class teaching

Fig 6.7 Group work

Fig 6.8 Cafeteria

(Modes of class organisation, Wiegand 1984)
adapted to cope with differing abilities lies with the teacher who must look at CAL as merely another resource and not as an alternative to his normal patterns of work.

Mode of Use of Software and Class Organisation

Perceptions of the effectiveness of a program will be influenced to some extent by the way in which it is used and the class organised. Shepherd (1980) conceived four models to demonstrate how this could be done (Fig 6.5), while Weigand (1984) outlines three modes of class organisation (Figs 6.6; 6.7; and 6.8). These vary from teacher centred, through a partnership to a student centred style. Hassell (1982), in assessing the impact of various styles concluded that a student centred approach proved most effective, since it generated a greater interaction and feedback. Similarly Nash and Ball (1982) conclude that:

"... computers often provide more discussion of the subject than do other methods of teaching it, and they entice teachers into setting open-ended problems where tightly structured exercises are the norm."

Most respondents indicated that they organised their CAL sessions around groups of pupils, although whether this was due to pedagogical considerations or to the shortage of hardware is open to conjecture.

Pupils almost always had a program demonstrated to them prior to use. Certain programs eg SEA-CLIFF EROSION lent themselves to use in an electronic blackboard mode, though
even here a pupil teacher partnership tended to be used. Only one program, SCALES, was used for teacher demonstration only, being noted as a "good visual aid". Indeed experience indicates that this is the only satisfactory way of using this particular program. Only rarely were pupils reported as using the computer by themselves.

Thus it can be concluded that, perhaps inadvertently, the organisation of CAL usage in geography classes already takes place in the most effective way. This would reflect the experience that geographers have already accumulated in the use of games and simulations, which also lend themselves to group work. Thus such an approach is natural, at least to the more progressive teacher. If CAL is already being organised well then problems are more likely to result from software and hardware deficiencies than from this particular cause.

The Relationship Between Published Reviews and Teacher Evaluation

a) The Nature and Value of Published Reviews When assessing text books for his classes a teacher is able to study them over a period of time and also try out sample material with a class. This is rarely possible with computer software. Even when approval copies are available the time allowed for assessment is often too short for the material to be evaluated under classroom conditions. Further, the teachers own CAL skills may be limited. Thus he is often forced to make choices based upon published reviews. Such reports vary
according to the status of the journal and the expertise of
the reviewer. Thus, for example a review in Teaching
Geography is likely to be of more value than in a non-
specialist journal. However, most reviews tend to be based
on limited experience, only The Journal of CAL providing any
form of long term evaluation. Thus it is possible that
teacher perceptions of CAL materials may be at odds with
those of authors, publishers and reviewers. This may be as a
result of problems with the software itself or as a result of
teacher misconceptions regarding what the program is trying
to do, and may also relate to teacher experience of CAL.

b) The Teacher and Other Reviewers — Some Examples
The above is well illustrated by various reviews of the
NELCAL package TOURISM. Futcher (1984) in Educational
Computing describes the programs as:

"... effective simulations that will enable
important aspects of the geography and economics
curricula to be treated in a new and exciting way."

Whether tourist development in the third world is an
important aspect of the curriculum is itself dubious, as is
the contention that the material is presented in an exciting
way. Certainly Richardson (1985) writing in Teaching
Geography is less enthusiastic, noting a range of
inconsistencies in the way that the programs handle "stupid"
inputs and the manner in which key details such as map scales
are omitted! She concludes that:

"Even though the gaming aspects of HOLIDAY 2
provide motivation, it does require numeracy and
it is hard to see how it could be used effectively with a large class. HOLIDAY 1 is tedious and would be better covered without a computer."

Two experienced CAL users evaluated the programs as part of the research and provided contradictory answers. Both indicated that the material could be taught by other methods and noted difficulties of organisation and of the time taken to work through the program. While one would recommend the package, noting to to be "stimulating ", and a "good learning aid", the other was more dubious, noting that its value would depend upon the syllabus and the time available.

However, while the first respondent has used the programs with the intended age range (14-16) the other had tried it with younger pupils (12-13) who may well have found difficulties with the conceptual level. All were agreed that the programs did promote discussion and debate amongst the pupils and also noted the the high standards of documentation and the ease of operation. Surprisingly neither respondent noted the problems mentioned by Richardson, although these become evident very quickly when the programs are used. Nor were the requirements for a twin disk drive on the BBC Micro and the slow speed of the programs mentioned.

On another note, would a radical geographer not also criticise the way in which the package projects an image of tourist development as being solely beneficial, ie is not only the conceptual basis of the package sound but does it
inculcate "correct" values and attitudes. This indeed is a point that does seem to be overlooked with this type of simulation. Ideally they should be open ended, allowing the student to reach his own conclusions and value judgements. However, most seem to suggest that, for example, certain developments are necessary eg, in MOTORWAY ROUTE, and while geographically accurate rely solely on the teacher to suggest alternatives to the received wisdom. Given the importance attached to values and attitudes in the GCSE examination this is a matter that requires further attention, otherwise there is a danger that CAL will lead to the inculcation of fixed ideas.

Thus it becomes evident that while the technical basis of a package causes little divergence of opinion this is not the case with the geographical structure and content. Here one returns to individual values and attitudes which are extremely difficult to quantify.

c) Packages Regarded as Quality Software

There are packages upon which there is general agreement as to their quality. SLICK has been almost universally praised and comments on this have already been noted. Cook (1984), in an extended review in Teaching Geography, concludes that this, "... is an excellent piece of software which I can thoroughly recommend to teachers." He goes on to note its versatility in terms of both age range and skill development, although being critical of programming faults such as the failure to disable BREAK and ESCAPE, minor factors which
could easily be corrected and will be, apparently in later versions of the program. The success of this package would seem to stem from a number of factors. In particular it has a sound conceptual base and combines the best of the worlds of simulation and gaming. It also fits positively into the modern curriculum at various levels, makes good use of graphics, is quite well written and is well documented. Although it is not perfect it does serve to indicate the principles of that which makes good software.

Similar comments may be made concerning the BBC Introducing Geography package of four programs. The editorial in Education Computing (Jan 1985) described them thus:

"What a package this is! . . . first rate simulations of immense quality . . . well planned and researched and the graphics are outstanding. This is real educational software, using the micro to is best advantage."

A subsequent review also praised the package highly and the responses from evaluators have been signally positive. The comments regarding the success of SLICK apply also to this package, but even more so, for the graphics and overall technical quality are superb for a BBC Micro. Perhaps the only note of criticism concerns the curriculum fit, especially of SUMMIT.

d) Packages Not Shown to be Advantageous

Certain programs that might appear to have a good curriculum fit and be technically sound fail to provide any real
advantage. Such is the case with MAPSKILLS 1 and 2. The use of OS maps being a basic geographical skill a program that can aid its acquisition should prove beneficial. However, respondents saw little advantage in its use compared to traditional methods. Indeed, the slowness of the programs and poor graphics proved a barrier with some pupils. Such views concur with those of Graham (1984) who in a review notes these same points, although considering the GRIDREF program at least to provide some benefit. Likewise with MICRO-MAPPING - a useful resource but limited.

Perhaps this is really a comment upon the value of tutorial CAL as much as on the programs themselves. Similar criticisms are also made of programs where a simplistic model is presented, but in its simplicity presents an inaccurate model, as with SEA-CLIFF EROSION, which was heavily criticised on this point in a TES review (March 1986). There is little excuse for such inaccuracies and others eg, procedures that draw rivers from sea to source when geographical models are so well understood.

e) Conclusion

the above clearly illustrates that in the majority of cases a review, particularly by geographer, will differ little from the opinions gained from a longer term evaluation. Certainly there would seem to be agreement on what may be considered "good" software, together with reservations concerning that which is poor or simply not of great benefit. It implies that in so far as Geography is concerned there is broad
agreement on this aspect of software and serves to confirm the indications on this matter given by the foregoing research evaluation.

Teacher Perception of Geographical Concepts Effectively Taught by CAL

It is apparent from the above that the most successful programs are those having a sound conceptual base. In the programs evaluated these aims and objectives were generally clear to the user and the package considered to adequately meet the same. Thus this would not seem to be a problem in the assessment of good and bad software.

Similarly, the concepts taught effectively by any particular program were obvious to the user, although how well this was done was open to debate, in particular where comparisons were made with regard to traditional methods as with map skills. Indications are that most success is gained where concepts concerning complex inter-relationships are involved. For example, in SUMMIT the relationships between decisions taken and conditions, in NOMAD between climate and farming success and in SLICK the need for urgent action based upon sound preparation in an emergency situation. That such concepts can be so effectively taught is indicative not only of the modes of teaching developed by geographers during the last twenty years but also of their willingness to transfer these to the computer. With the computers speed and almost instant response these techniques, developed as manual systems, will be further developed in a most stimulating
manner.

Summary of Findings and Conclusions

The debate over the evaluation of CAL materials will continue for some time. CAL is still in its infancy in British schools in so far as its availability and the skill and experience of teachers using it are concerned. However, a number of conclusions may be drawn from the evaluation exercise detailed above. If the question of evaluation strategies may be considered first of all then:

a) Although there is difficulty in defining "good" software it is clear that there is a distinct relationship between that which is good and that which is considered by the end user to be effective. The material also reaches basic technical standards though failure to do so does not necessarily detract from its effectiveness in an educational sense.

b) Although a variety of evaluative techniques have been developed it is the teacher and pupil who determine ultimately whether a program is of use. It is they who should form the basis of the formal evaluative procedure.

c) All assessments of software are to some extent a matter of personal opinion, although this may be guided by both experience and agreed assessment criteria.

Secondly, it is evident that software considered effective by
both teachers and independent reviews do, as contended, exhibit certain identifiable characteristics. In particular an effective program should:

a) Have clearly defined aims and objectives which are obvious to the user.
b) Have a sound conceptual base.
c) Provide accurate geographical models.
d) Be technically sound.
e) Use colour graphics.
f) Be fully interactive.
g) Have an obvious curriculum fit.
h) Be potentially usable with a range of ages and abilities.
i) Be either a simulation or a tool such as a database.
j) BE WRITTEN TO PROFESSIONAL STANDARDS.

While the above is not exhaustive it serves to indicate the basic tenets of the design of software for use in geographical education. As such it is offered as one route for the development of interesting, lively and effective CAL materials that will enhance geographical education in British school.
Pupil Perception of Software Regarded as Effective by Teachers

While teacher perception of good software is of paramount importance the pupils themselves are as much end users of software as are teachers. If they find the material dull or lacking in motivational appeal the whatever the merits of the particular package it is likely to fail the ultimate test of effectiveness. In order to assess this aspect of evaluation a short comparative questionnaire was provided for pupils to record their views of various programs. This was done for fifteen programs, of varying appeal to teachers.

It was hoped that such a survey might reveal any fundamental differences in perceptions and indicate whether these could be overcome. However, although answers to multiple choice questions yielded useful data responses to open ended questions proved disappointing, with too many simplistic and flippant comments. Despite these problems sufficient material was gathered to provide an indication of pupil perceptions on a number of aspects of both software and the use of computers in the geography classroom. However, the questionnaire technique of gathering data gives no indication of the effect of the teacher on determining pupil attitudes and opinions towards both the software and CAL in general.

Pupil Attitudes to CAL

The most interesting evidence relates not to particular
software but to pupil attitudes to CAL itself. However, it must be noted that since it is not possible to be sure that programs and/or context were not badly chosen the evidence is not totally reliable and the following should be considered in this light.

It has often been said that pupils relate naturally to the computer, enjoy using it and learn more effectively though its use. That this assumption is incorrect is indicated by 53% of pupils expressing no particular opinion as to their enjoyment of a CAL session, with a telling 17% actively disliking such work. Of the 30% who enjoyed the CAL sessions a great deal the majority had little previous experience of CAL, and could thus merely have responded positively to a new method of working.

Even given such a small cross-section of a mere 53 pupils, these figures are enough to give rise to some concern. Many teachers have tended to assume that the computer itself is a motivational tool, which on the basis of these data is clearly not the case. Furthermore, since the question related specifically to the program in use a rejection of CAL software is also indicated. It would thus appear that there is considerable scope for further research into pupil attitudes to CAL and thus to the implications of computers on curriculum design. Although some work has already been done by Watson (1982) and ITMA the requirement for a long term study is indicated.
The Effect of Home Computer Ownership

The majority of pupils have had some computer experience outside of the school situation, with 70% of respondents indicating ownership of a home computer. They have thus been exposed to a variety of technically excellent games software that is conceptually disastrous in educational terms. It is probable therefore that pupils will tend to judge educational materials against these standards, despite the fact that the two types of software are designed for very different purpose.

CAL as an Aid to Understanding

On a positive note some 59% of the pupils found the use of CAL to be of some use in aiding their understanding of a particular topic, with 9% indicating that it had helped them a great deal. Further, although 32% indicated that it had been of no help almost half had used the program(s) outside the classroom sessions. Responses concerning specific areas of benefit are difficult to quantify for the reasons noted earlier. However, it does appear that different aspects of a program aided different pupils, although all using QUEST and CENSUS DATA BASE agreed on its value as a tool which alleviated a difficult and possibly onerous task for them.

This does serve to indicate that pupils are able to perceive a benefit in some aspects of educational computing and that such programs are thus effective in use. Similarly, programs such as SUMMIT and RIVER must also be considered as such since here pupil perceptions match those of teachers.
Technical Aspects

The particular attraction of many programs for seems to lie in their high quality graphics as witnessed by such comments as, “the graphics were brilliant!”. (Shades of games software?). Certainly poor quality graphics and those that did not make full use of colour were heavily criticised, e.g. in SAXONS, as were graphics screens that were slow to plot as in SALFORD. In such cases pupils are no doubt comparing slow BASIC procedures with the machine code of games software. On a more general technical point 95% of respondents found instructions and information screens easy to read, and 79% the graphics screens clear and easy to understand. Even so a not inconsiderable 21% found difficulties in this area.

Educational Concepts

In so far as the educational roles of the programs were concerned there seemed little difficulty for users in recognising the concepts embodied in the software. However, a note of caution must be inserted, for it is not obvious whether this is due to any inherent feature of the software itself or to a teacher explanation of the concepts prior to use of the computer. It does seem apparent though that in this aspect CAL is not at any disadvantage compared to more traditional methods.

Effects of Class Organisation

As previously indicated most lessons were organised around groups of pupils using the computer. Given the interactive
nature of the programs assessed by pupils such organisation is appropriate. Unfortunately no response was obtained from pupils who had used the computer in an electronic blackboard mode, although a number had experienced teacher/pupil partnership use. It is thus not possible to assess whether such a mode of use would be regarded as inferior or less motivating by pupils. Since pupils generally enjoy their "hands-on" time it is probable that they would find the electronic blackboard no more motivating than a film strip or video cartoon. Certainly this is indicated by my personal experience.

Conclusions

The above analysis is necessarily brief, yet a number of relevant points arise which may be summarised below, together with relevant conclusions on the same:

1. There is a general agreement between the views of teachers and pupils regarding the most effective types and styles of CAL.

2. Successful programs in the eyes of pupils are interactive, make full use of colour graphics, are not tedious in use and have an obvious purpose.

3. Pupils seem able to recognise and appreciate the concepts embodied in successful software.

4. Individual and group work where the pupils are actively
involved with the computer appear to generate the most positive responses.

5. Despite rather negative responses concerning attitudes to CAL pupils appear to recognise its value in aiding their comprehension of the topics taught.

Thus it may be concluded that the general features of software design indicated in the previous chapter are confirmed by these findings. However, given the dichotomy between teacher experience of computing and pupil experience via home computers there is a need for further research into the area of pupil attitudes and perceptions in this area if we are to ensure that CAL materials of the highest standards are created in the future.
CHAPTER 8

General Conclusions

This chapter will draw together the findings of the research project and will, on the basis of these findings attempt to define those areas of geographical education in which computers are currently being used, together with the difficulties posed by both hardware and software availability. It will further draw conclusions upon the nature of the software currently in use and the elements in that software that teachers and pupils find successful and effective. Recommendations will be made as to how such elements might be incorporated into future software, whether entirely new or a development of existing materials.

In order to put the conclusions that follow into perspective it is important that sight is not lost of the original hypotheses upon which the research is based. These proposed that:

1(a) There are areas of geographical education in which CAL techniques can most appropriately be employed.

(b) The characteristics of software that best promotes effective learning in these areas can be identified.

2 Access to hardware is a significant limiting factor in the development of CAL.
As may be seen from the preceding chapters the data obtained, based upon the experience of practising teachers of Geography, confirms the contentions of the hypotheses. In the case of the first it has proved possible to identify those topics in which CAL is used, together with the nature and style of those materials. It has further demonstrated that there are elements inherent in certain items of software that render them more successful in the opinion of the users and these have been identified. Regarding the second hypothesis conclusions may be drawn regarding the crucial factors limiting the future development of CAL in British schools together with indications of the organisational strategies employed to overcome these problems. These are discussed in detail below.

Conclusion on CAL Usage in School Geography
Although it might be expected that CAL is widely used in many aspects of school geography this does not seem to be the case. Certainly there are few regular users of the medium, the small sample survey indicating them to comprise less than 10% of teachers, a figure similar to that given in the final MEP report (1986). Although a recent survey by Russell (1985) is rather more optimistic it still indicates that nationally 62% of schools do not use CAL in geography teaching at all. It is against such a background of limited interest and activity in the area of CAL that conclusions relating to software must be set. However, even though usage is currently low, existing practice and experience, of which
The sample schools provide a microcosm, has already developed distinctive patterns. In view of the conservative attitudes of teachers and the relatively slow rates of change in education these patterns are likely to remain fairly constant for some time, particularly as forced developments such as GCSE and the National Curriculum may take priority in terms of time and finance.

The main conclusions regarding this section of the work have been indicated in the relevant chapter. However, here they will be discussed in relation to recommendations for future development.

Computers in Use

The BBC Micro in its various guises is the dominant machine in schools use despite those who consider that other, lower cost machines could do the job as well as or better than this computer. Few authorities have adopted computers from Research Machines. Given that BBC Model B computers and BBC Master computers are not fully compatible this means that there are incompatible standards in use, with two others, the RM Nimbus and the Acorn Archimedes beginning to appear in schools which will add to the difficulties.

Unfortunately no rigid standards appear possible for software, this being the conclusion also of the NCC (1986). The implications are that software will continue to be written for a variety of machines, presumably, and where possible, in a portable sub-set of BASIC. Given the limited
power of the thousands of machines currently in school it is possible to foresee a situation in which software continues to be written for these and does not therefore make use of the large memory and enhanced graphics capabilities of newer micros. Certainly if parallels may be drawn with home computing, especially as regards games machines, new developments mean transferring to a new machine with a new software base - an expensive exercise for schools. Similarly, with high development costs, and a small market, software houses may well not develop the advanced software that the new machines can handle.

There is not an easy answer to this problem. By adopting machines that are somewhat esoteric and non industry standard schools have been left isolated from mainstream computer developments. When even the otherwise excellent Archimedes requires a £100+ add-on package to enable it to run MS DOS software one wonders exactly where educational computing is really heading.

Access to Hardware
Following from the above is the major problem of access to hardware. This concurs with the findings of Russell (1985) and must form the main stumbling block to the development of CAL in schools. However, good the software its purchase cannot be justified if access to computers is limited or impossible. With two thirds of schools reporting access problems this is an aspect of educational provision that
clearly requires considerable attention especially as the
typical ten computers in a secondary school will be in
increasing demand due to the new IT Across the Curriculum
policies currently being adopted.

While some departments were fortunate to possess their own
departmental micro this, while beneficial does not solve the
problem. Even with groups at the computer only those
programs with a short run time can be used during a typical
lesson. Use of word processing, spreadsheets and prolonged
use of a database by individuals is clearly not possible.
Indeed, many teachers may well be tempted to use the computer
merely as an electronic blackboard. For those teachers who
have to transport computers and peripherals to a classroom the
logistical problems are an active discouragement to using the
computer at all.

There is no easy answer to this problem. Even taking the
Hampshire option, currently proposed, of fifteen Archimedes
machines on a network is not a solution, although an
expensive attempt at one. The simple fact remains that if
CAL as a teaching method, and the use of IT in general across
the curriculum are to develop then schools must have more
computers.

Software Types
Of the software in use two forms are dominant, the simulation
and data handling. This is in part a reflection on the way
in which the early developments of CAL took place in this
country and also serves to show those areas in which CAL practitioners have found the greatest value for the medium. Certainly it confirms the perception of the computer as a tool for learning which was evident in many responses. The alternative concept of a teaching machine in the PLATO or TICCIT vein is of little importance, except where it is useful for the teaching of a specific and limited range of skills.

**Topics Where CAL is Currently Used**

In so far as those subject areas where CAL is used are concerned it is evident that physical geography dominates the field. This is not unexpected, since not only do slow physical processes lend themselves to computer simulation, the ability to try our "what if?" questions being particularly useful, but fieldwork in this area generates much data which can best be analysed by using a computer. Other areas in which CAL is frequently used include the study of agriculture, settlement and population, together with skills in mapwork. However, a note of caution must be entered here for there is a distinct probability that a correlation exists between these areas of use and current curricular patterns.

Little use of CAL took place in other areas of the geography curriculum, either a reflection of the above point, or a lack of perceived applications. The availability of suitable software must also be considered a factor. Further research would seem to be indicated on these points, perhaps enquiring
into those areas of the subject in which teachers would like to use CAL but are currently unable to do so, together with relationships between CAL requirements and curriculum development.

Sources of Software
At the present moment the market is dominated by a small group of large publishing houses, notably Longman. Although small specialist publishers have taken a minuscule share of the market their survival is unlikely unless they diversify and their loss could have implications for future software developments and the maintenance of existing material. Unfortunately the ultimate problem is finance. Only large corporations are able to either negotiate subsidies from government agencies or to absorb development costs, thus enabling materials to be supplied at a cost that schools can afford. Similarly such publishers are likely to be the ones who gain the benefits of publishing materials developed by the various project groups.

Summary
The above clearly indicates that CAL has established a place in several areas of Geography teaching. However, due to the problems outlined its survival other than as an interest for a minority of enthusiasts is problematical. In particular the problems of hardware access, together with the cost of software tend to dissuade the uncommitted from developing its use. The quality of the software, while ultimately of great importance, is less so in the early stages. While, as will
be shown below, there are difficulties in this area, good software can, and will, be created as our approach to the use of IT in schools becomes more professional.

Conclusions Regarding the Characteristics of Effective Software

Two threads may be discerned concerning effective software. The first relates to the technical standards of the materials, the second to its educational value as perceived by both teacher and pupil. Good software takes account of both of these requirements, although much software that is defective in some technical aspects has been found to be extremely useful. However, it is evident that the general quality of much educational software does leave much to be desired, as has been widely noted, and that these deficiencies require to be remedied if the use of CAL is to become more attractive to teachers. The research clearly indicates that certain characteristics can be identified that are not only desirable but in many cases essential features of good and effective software.

Technical Aspects of Effective Software

It should go without saying that effective software should be technically sound. No teacher has time to waste with material that will not load, crashes easily or exhibits too many irritating bugs. What is required is a resource that is as easy to use as a filmstrip, cassette player or video recorder. The computer has long suffered from an air of mystique and software of poor technical quality can only
maintain this situation. Evidence suggests that all software should attempt to meet the following criteria for effective classroom use:

a) Program should load easily and accurately.

b) Program should operate as per documentation.

c) Bugs should be eliminated prior to publication.

d) The program should be simple to use by pupils of a wide ability range.

e) Text screens eg of instructions should be kept a minimum.

f) Help in case of difficulties should be available from within the program (preferably) or from the documentation.

g) High resolution graphics should be used where their application enhances the program. Excessive use of graphics for their own sake is not acceptable.

h) All graphics should make full use of colour.

i) Colours should be carefully chosen with regard to their visibility both on colour monitors and when the program is run with a mono monitor.

j) Clear and concise documentation should be provided together with worksheets or suggestions for ways in which the program could be used in a variety of situations.

While the above is not prescriptive it demonstrates the broad requirements indicated by actual CAL users. While allowing for the problems of the memory size of current school
Computers especially where high resolution graphics are concerned the above does not represent an impossible target for a good programmer. After all, most educational programs are very short when compared to those for commercial use, although it could be argued that a good short program is more difficult to write, especially if available RAM is limited. However, teachers have as much right to expect quality as do commercial users. Quality is not cheap however, although the price of good software for PC clones for example is now very cheap in comparison to schools materials, indicating perhaps that teachers are not currently receiving value for money. As with hardware, finance is the real answer, whether through increased capitation allowances to schools or via subsidies to the publishers. The only other alternative, though as yet it is not very evident, is for LEA's, either individually or in consortia, to develop their own materials.

Educational Aspects of Effective Software
Technically sound programs are of little value if their educational foundation is weak. Programs which are little more than electronic pencil and paper have been widely criticised, and rightly so, for they are mere gimmicks with little long term value. However, within the software evaluated as part of this research there became evident a number of educational aspects that contributed to the teacher perceiving that particular program as effective. In retrospect these may appear obvious, but they are apparently lacking in much published material. In particular the following features were noted:
a) Effective material has clearly defined aims and objectives which are obvious to the user.
b) Good software has a sound conceptual basis again apparent to the user.
c) Interactive programs are preferred.
d) Models used should be accurate.
e) Simulations are considered to provide the most effective use of CAL, together with its use as a tool for data manipulation.
f) Software should have an obvious curriculum fit, although this may relate to a developing as well as an existing curriculum.
g) Material should be capable of use with a range of ages and abilities.

Similar pointers to effective software were apparent in pupils responses also.

This project has indicated that there is now a consensus amongst Geography teachers regarding the main characteristics of effective software. Such technically and educationally sound materials are already available, as demonstrated by the BBC Introducing Geography package, but not, as yet, in the quantity desired. While adherence to the above may not prove a panacea, nor provide software that is regarded as wholly effective by all users, it provides a basis for the future development that will serve the needs of the majority of teachers of Geography.

Implications and Recommendations
CAL techniques have now formed a part of the teaching of Geography for a number of years and the subject may be considered to be in the forefront in this field. However, the research indicates that regular use of CAL is limited and that while many teachers have paddled in the shallows few have dived in with any conviction. Hall et al (1985) noted the striking speed of CAL development and certainly from the minuscule base that existed prior to the MEP and DTI scheme this is true. However, they go on to note that many potential users are likely to be inhibited and prejudiced by the inheritance from an earlier era of CAL, viz software that is either simply empirical or of a mechanical, skill reinforcing nature.

However, it is evident that much software that is well written, interactive and both useful and effective is now available and proving extremely beneficial in those classrooms in which it is being used. There remains the problem however, of encouraging the majority of teachers to take up the use of CAL. Software per se is not the key problem, for future materials are likely to improve in quality, particularly if the findings of this and other research are adopted. Yet if teachers do not see the software they will be unable to appreciate its value. Few teachers attend exhibitions and the like, nor do they have the skill or opportunity to acquire and evaluate materials prior to purchase. Furthermore access to the computers is often difficult.
Thus we have a situation in which experience has demonstrated those areas of Geography in which CAL has been found to be beneficial, together with the nature and style of software that has proved effective. Yet, because of logistical problems, difficulties in reviewing materials, lack of training and finance the take-up of CAL is severely restricted. In view of this it is perhaps worth noting here some recommendations for alleviating this situation and thus aiding the development of CAL in Geography:

a) Future software should be developed according to the guidelines for effective software noted above.

b) Materials should be developed that meet modern curricular requirements.

c) Facilities for the pre-purchase inspection/review of software should be improved.

d) The present ad hoc forms of in-service training have proved inadequate. While compulsory training might meet with opposition it would seem to be the only way of confronting potential CAL users with the possibilities of the medium. Certainly there is a need for training courses specific to the requirements of geography teachers.

e) Steps should be taken to ensure that schools have access to adequate numbers of computers. The financial implications are self-evident, but must be faced if CAL is to become neither an
esoteric sideline nor the preserve of the fortunate few. The MEP budget, "worth one chocolate per school child per year", (Hall et al (1985)) was itself inadequate for the task given. Research and development is not cheap; failure to capitalise on our experience of CAL will prove considerably more expensive.

f) Software of high quality must be made available at prices that schools can afford, whether through subsidies, increased capitation or other means.

Teachers must be encouraged to use CAL. At the present time the situation is such that they are more likely to be discouraged by the myriad difficulties placed in their path.

Areas For Future Research

This project has done little more than scratch the surface of a new and developing educational resource. If we are to fully understand CAL considerably more research will be required in many areas. Although in geography developments would seem to be following a positive line there remain many areas of concern. In particular the following areas were indicated in which further research would prove beneficial:

a) Although elements of effective software have been deduced this area would benefit from further study.

b) Pupil attitudes to CAL (and IT in general) are a key element for successful CAL implementation
yet there seems to be little UK work in this area.

c) Studies of pupil interaction with effective software.

d) The influence of software styles and structures in both implicit and explicit curriculum models applied in Geography (after Morely & Sage (1983)).

Other areas in which research might prove beneficial could no doubt be suggested, but the above would further the development of CAL as an effective resource in geographical education.

Thus at the end of this paper we stand looking forward with hope and not a little optimism. the situation portrayed above demonstrates many difficulties, yet these are either being overcome or are capable of being overcome. CAL in geography has a bright and exciting, if difficult, future and one can do no better than to conclude with the words of Ifan Shepherd (1983) who said to those in doubt, "come on in, the waters fine!".
Postscript

During the three years of part time work that it took to design, implement and complete this research a number of significant developments have taken place regarding the use of IT in schools. These centre around technological developments on the one hand and changes in the structure of support groups and government policy on the other.

Technological advances have, to some extent passed schools by. While industry went in a big way for clones of the IBM PC, machines which are both cheap and powerful, education struggled on with the outdated BBC Micro and its successor the BBC Master. It is to be hoped that the advent of the new Acorn Archimedes into schools will improve this situation and at last provide schools with the computing power that they need for the future. The use of on-line systems such as TTNS and Dialcom Education are again new developments that simply did not exist back in 1984, yet provide new and powerful tools that few teachers have yet exploited.

Indeed the only real problem with technological advances in educational computing will lay in ensuring that schools are able to keep up with it. While 2 years may be a long time in computer development it is extremely short in schools where equipment tends to last, intentionally or otherwise for many years - I have yet to come across a school with a proper replacement budgeting policy, yet this is essential with
In terms of a support structure there have also been welcome advances. The demise of MEP in 1986, after an all too short period as the prime mover that enabled CAL to gain a solid foothold in our schools, marked not an end but the beginning of the future. MESU (Microelectronics Education Support Unit) has proved to be every bit as useful as its predecessor. By actively supporting software development and by producing recently (mid-1988) an excellent initial and in-service training pack, Learning Geography With Computers, it is providing the level of support that is needed to push CAL past the take-off point that seems so far to have eluded it.

Other government initiatives will also have beneficial effects. In particular the employment of subject IT advisers in every LEA under an MSC funded project will at last allow a realistic training programme to begin. With the concurrent move to ensure that all students in initial training gain some computer experience we are heading for the day when a sizeable proportion of the teaching force will at least have had a basic grounding in the use of information technology. However, once the proverbial horse has been led to water can it be made to drink? Only time will tell on this point!

Pessimists, noting the low take-up of CAL at the present time may remain cynical. With a teaching force often disillusioned by poor pay and conditions and a plethora of new curriculum initiatives it may be that the computer is the
one that will be rejected; after all one can still teach successfully without using computers. However, with any new technological development there will be a long lead time during which usage remains small as only the forward thinkers experiment. This is of course the situation in which we have been for the last ten years. There are indications that this is now coming to an end and that we shall see a rapid growth in CAL usage during the 1990's.

Ultimately the potential exists, and will increase as technologies develop, for the integration of CAL into every teachers repertoire of techniques. If we fail to take up the challenge and make full use of the benefits that it offers we will have failed both ourselves and our pupils. Would future generations forgive us such folly?
APPENDIX 1

INITIAL QUESTIONNAIRE - ANALYSIS OF RESULTS

Addendum

a) BREAKDOWN OF RESPONDENTS

Hampshire - 21
GA Software Review Panel - 11
CAL Geog Research Group - 1
Other LEA’s - 15
TOTAL 48

2. HARDWARE ACCESS

Respondents 48
No problem 13
Some problem 19
Major problem 15

Overall 34 respondents indicated access problems severe enough to effect CAL usage.

3. RESPONSES IN REGARD TO NON-USE AND LIMITED USE OF CAL

The following were mentioned:

a) lack of available software
b) lack of time to fit into syllabus
c) lack of time to find suitable software
d) limited time for preparation
e) available software limited for schools requirements
f) lack of time
g) no opportunity to use computers/lack of access to hardware
h) teacher has had no incentive to use CAL
i) teacher lacks training and expertise
j) finance
k) CAL is in early stage of development (implying that the techniques should not therefore be used!)
l) present programs too simplistic (though expects improvements with time
m) data manipulation the only key area of advantage.

4. SOFTWARE

Total number of programs mentioned by respondents - 170

Programs in most common use included:
a) BBC Introducing geography package
b) BBC Advanced Geography package
c) Schools Council Computers in the Curriculum series
d) GA/MEP package

NB Many programs were mentioned on only one occasion.

CLASSIFICATION BY PROGRAM TYPE:

a) Simulations and games 67
b) Tutorial/drill & practice 30
c) Quantitative/data handling 49
d) Content free/non specific 2
e) Text handling 6
f) Unclassified 18
Unclassified includes private and LEA programs under development for which insufficient information was provided to allow formal classification.

Of the 170 programs only 10 were authored privately. With the exception of a number under development by Kent LEA they were all published material, with that from Longman proving dominant.

5. PERCEPTION OF THE ROLE OF CAL

Edited responses were as follows:

a) simulations - interactive, experimental, allowing immediate response, active/experiential learning
b) encourages pupil involvement in learning process and thus aids understanding and reasoning
c) reinforcement of ideas
d) CAL as another resource - notes that trad methods can be just as successful. CAL as a learning tool
e) a motivator
f) allows greater emphasis on method by reducing content
g) CAL as a curriculum extension freeing the teacher within the classroom
h) a useful data and text handler and presenter
i) role in IT experience
j) allows individual and small group work both in simulations and drill and practice
k) a resource for enquiry learning
l) remedial and extension work
m) a tool for the introduction of complex ideas
n) animated blackboard - useful with younger children
o) not a panacea for educational problems - could founder on poor software
p) an independent learning tool
q) CAL as an enhancement for high flyers in a mixed ability situation
r) an aid to learning facts and skills
s) limited value due to inferior software compared to that for home micros
t) as a tool for the teacher e.g. in producing worksheets

6. BREAKDOWN OF PROGRAMS BY SUBJECT

SIMULATIONS

a) Physical 17
b) Agriculture 11
c) Settlement studies 7
d) Transport 9
e) Economic 14
f) Population 3
g) Mapwork 4
h) Unclassifiable 3
The large number of programs not classified is due to the fact that many databases, spreadsheets etc have a wide range of applications.
<table>
<thead>
<tr>
<th>Category</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>e) Economic</td>
<td>21</td>
</tr>
<tr>
<td>f) Population</td>
<td>8</td>
</tr>
<tr>
<td>g) Mapwork and mapping</td>
<td>29</td>
</tr>
<tr>
<td>h) Not classified</td>
<td>50</td>
</tr>
</tbody>
</table>

**SUMMARY OF PROGRAMS BY PUBLISHER**

<table>
<thead>
<tr>
<th>Publisher</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Longman</td>
<td>36</td>
</tr>
<tr>
<td>b) Hutchinson</td>
<td>8</td>
</tr>
<tr>
<td>c) BBC</td>
<td>11</td>
</tr>
<tr>
<td>d) MEP</td>
<td>10</td>
</tr>
<tr>
<td>e) LEA</td>
<td>17</td>
</tr>
<tr>
<td>f) SCi Ed Soft</td>
<td>5</td>
</tr>
<tr>
<td>g) Cambridge/Netherhall</td>
<td>4</td>
</tr>
<tr>
<td>h) Southern Gas</td>
<td>1</td>
</tr>
<tr>
<td>i) Council Env Ed</td>
<td>1</td>
</tr>
<tr>
<td>j) Ginn</td>
<td>1</td>
</tr>
<tr>
<td>k) Solent Software</td>
<td>2</td>
</tr>
<tr>
<td>l) BF</td>
<td>1</td>
</tr>
<tr>
<td>m) Heinemann</td>
<td>3</td>
</tr>
<tr>
<td>n) NELCAL</td>
<td>5</td>
</tr>
<tr>
<td>o) Jcaranda Wiley</td>
<td>1</td>
</tr>
<tr>
<td>p) MJP Publications</td>
<td>4</td>
</tr>
<tr>
<td>q) Arnold Wheaton</td>
<td>2</td>
</tr>
<tr>
<td>r) Acornsoft</td>
<td>2</td>
</tr>
<tr>
<td>s) Bourne Ed Soft</td>
<td>2</td>
</tr>
<tr>
<td>t) Chalksoft</td>
<td>1</td>
</tr>
<tr>
<td>u) ITV</td>
<td>2</td>
</tr>
<tr>
<td>v) AVP</td>
<td>3</td>
</tr>
<tr>
<td>w) Beebug</td>
<td>2</td>
</tr>
</tbody>
</table>
The non-specific element includes programs for which no publisher or author was given, programs in private circulation and those not yet published eg second series of Loughborough/GA programs.

7. BREAKDOWN OF CAL USAGE BY AGE RANGE

This is presented as a percentage of the total CAL usage indicated by respondents

<table>
<thead>
<tr>
<th>Age Range</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>9 - 11</td>
<td>7%</td>
</tr>
<tr>
<td>12 - 13</td>
<td>21%</td>
</tr>
<tr>
<td>14 - 15</td>
<td>24%</td>
</tr>
<tr>
<td>15 - 16</td>
<td>25%</td>
</tr>
<tr>
<td>16+</td>
<td>23%</td>
</tr>
</tbody>
</table>
TRIALS QUESTIONNAIRE

Name of Unit:

Name of School:

Name of LEA:

Program Version:

Date:

Type of School:

Age Range of School:

Use of the Program

1. Was the program used with: (a) a whole class? (b) small groups? (c) a single pupil?

2. Numbers in the class/groups?

3. Age of pupils?

4. Ability range of pupils: (a) more able? (b) average? (c) less able? (d) mixed ability?

5. Number of teaching sessions for which the program was used?

6. Average time per session given to the program?

7. Was whole/part of the program used? Please give details.

8. Was the complete program run through with each class/group once/more than once?

9. Was this the first time the class had used the program?
10. Was there any preparatory work prior to the class/group seeing the program? 
   If yes, please give details.

11. Was there any follow up work after the program? 
   If yes, please give details.

12. Were there any difficulties in using the program? 
   If yes, please give details.

13. Was the screen display always easy to read? 
   If no, please give details.

14. Does the program structure make it easy to use? 
   If no, please give reasons.

15. Does the screen display change: (a) too quickly? 
   (b) too slowly? 
   (c) at the right speed? 
   Please give details if necessary.

Teachers Guide

1. Was the guide used by the teacher?

2. Did the teacher refer to the guide regularly?

Student Material

1. Did the student use their leaflets: (a) not at all? 
   (b) infrequently? 
   (c) frequently? 
   If frequently, please give details.
2. Was the student material provided:  
(a) sufficient?  
(b) insufficient?  
(c) excessive?  
Please give details.

3. Were the leaflets easy to follow?  
If no, please give details.

Bugs

Did the program fail to operate properly at any point?  
Please give full details.

Any Other Comments

Your free-ranging comments on the use of this program would be welcomed.

Name of Observer:
Signature:
Date:
1. MODE OF USE

- TEACHER ONLY EVALUATION
- LARGE SCREEN CLASS USE
- INDIVIDUALISED LEARNING
- NETWORK USE

COMMENTS

2. RELEVANCY OF PROGRAM

- EXCELLENT
- GOOD
- FAIR
- POOR

COMMENTS/SUGGESTIONS

3. RELEVANCY OF PUPIL/TEACHER MATERIAL (IF ANY)

- EXCELLENT
- GOOD
- FAIR
- POOR

COMMENTS/SUGGESTIONS

4. PUPIL STIMULATION/INTERACTION

- EXCELLENT
- GOOD
- FAIR
- POOR

COMMENTS/SUGGESTIONS (ESPECIALLY LEARNING DIFFICULTIES)

5. SOFTWARE/HARDWARE PROBLEMS (IF ANY)

DETAILS

6. ANY OTHER COMMENTS?
<table>
<thead>
<tr>
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<th>MACHINE</th>
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<tbody>
<tr>
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<tr>
<td></td>
<td>NAME</td>
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<td>SCHOOL</td>
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**GENERAL COMMENTS.** (Noting the following areas:)

- (a) Best use of program - demonstration/interactive/1 micro/memory, etc.
- (b) Outline of work into which program was integrated.
- (c) Additional resources needed/desirable.
- (d) Recording of results/writing conclusions by students.
- (e) How is learning assessed during and/or after run.
- (f) Extent to which program achieves its stated aims.
- (g) Geographical accuracy.
- (h) Flexibility of use over age/ability/time.

Continue overleaf if necessary.
This prompt sheet is intended to form the basis for classifying CAL software, in preparation for cataloguing and inclusion in the CRIC CAL Software Library.

<table>
<thead>
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<td>TYPE</td>
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<td>LEVEL</td>
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<td>(age group/exam)</td>
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M. DORAN
March 1982
Software Preliminary Evaluation Sheet

This preliminary evaluation sheet is intended for use with undocumented software, for which little or no useful information has been provided, and which may be in some intermediate stage of development. The following prompts are intended to elicit responses, which can establish whether or not the software has any future in the classroom, and to provide information for preliminary classification purposes.

**Title (or file name)**

**Source**

**Level (age group/exam)**

**Description (briefly)**

**Distribution Restrictions**

**Microcomputer (eg 380Z)**

**Language (eg BASIC V.5.0)**

**Operating System**

If known, e.g. BS 3.4/CP/M 1.4B)

**Special Hardware**

eg HRG, Printer, col Colour)

**Comments** (After completing the second side of this evaluation sheet, any additional comments which you think may be helpful at this stage can be stated here).
USER IMPRESSIONS - (to establish the ERF* rating)

Against each of the three headings (Educational, Robust and Friendly) tick the box adjacent to the most appropriate description.

Educational?

1. No educational value; or fails completely in its apparent aims; or its apparent educational aims could better be achieved by other means than a microcomputer.

2. Has some educational value, but the medium has not been fully exploited to achieve the apparent aims, particularly in relation to the flexibility of style, pace and level of presentation.

3. Good educationally; motivating and an effective learning medium for the pupil; responsive to the particular teaching style of the teacher.

Robust?

1. Program behaves erratically, or crashes irrevocably.

2. Program performs adequately, recovering from user errors, but not particularly helpful or informative operationally.

3. Program is uncrashable, and, provides helpful error messages and operational support.

Friendly?

1. User/machine dialogue is awkward and confusing, and screen presentation is incomprehensible.

2. Adequate user interface, but I/O facilities are not fully exploited to make dialogue/comprehension easy.

3. Dialogue arrangements are convenient and efficient; screen presentation is clear, with effective use of graphics where appropriate.

Transfer the numbers alongside the ticked boxes to obtain the ERF rating.
### SOFTWARE REVIEW

This form was designed by the Essex Remedial/Special Education Computer Panel.

<table>
<thead>
<tr>
<th>PACKAGE TITLE:</th>
<th>PRICE:</th>
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<th>POOR *)</th>
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</table>

### ASSESSMENT

Program tested by

At

When

With (PUPILS/STAFF *)

(GROUP/INDIVIDUALS *)

N.B. Reviewer please consider:

Program objectives/if achieved? ease of use: crash-proof?

Style (Drill & practice/simulations/model checking/or other)

Suitable for (ages/ability/individuals/groups)

Presentation (colour/quality/readability/does it ‘grab’ them)

Snags/drawbacks/recommendations/rel. to other material

### REVIEWERS COMMENTS

* Underline as applicable
SOFTWARE REVIEW

Package Title: 

Machine Specification: 

Package Contents: 

Distributor/Publisher: 

REVIEWER, PLEASE CONSIDER:

(a) How this package may or may not significantly and genuinely enhance the teaching/learning process within the area of the curriculum to which you consider this package is applicable.

(b) Whether this package is a potential contribution to the development to good classroom practice for the age range for which you consider it is applicable.

(c) Standard/suitability of documentation; subject area; target audience; program objectives and learning objectives; pupils' reactions; etc.

REVIEW

Name of Reviewer: 

School: 

Please continue overleaf and on additional paper as necessary.
Evaluation Of Geography Software

Much has been written on the evaluation of software, but in realistic terms, what the teacher in the classroom requires is a competent, concise and objective assessment of what a particular program can offer. Software is expensive and prejudices usually extremely difficult or often impossible. Too often teachers have misguidedly purchased expensive programs, influenced in no small measure by the "glossy" publishers advertising only, to find that use is minimal and restricted to a minor area of the curriculum or a specialised clientele. In order to assist teachers in a more informed manner, an evaluation procedure was designed and has been adopted by a representative group of geography teachers within the ILEA who have commenced the evaluation of selected geography programs utilizing this format.

Such a structure is not exhaustive in coverage, nor is it supposed to be, it allows the reader to ascertain the specific nature of a particular piece of software that has been extensively evaluated by a group of practising geography teachers, and to do this in a relatively short period of time.

Essential factual information concerning the nature of the software is given, while an important area, often neglected centres on the question that pupils may require prior to the use of the software within the classroom. This must be a requirement for the effective integration of software into an overall curriculum strategy. An assessment of documentation forms a major component of the evaluation procedure. Geography teachers expect (and should expect) detailed information on how a particular program can be integrated into their teaching with suggested procedures and pupil activities. In addition, documentation that provides accompanying pupil's worksheets or notes can be beneficial, although in some cases it has been noticeable that authors of geography software seem blissfully unaware of the practical levels of ability evident in classrooms. This has been aptly demonstrated on occasions where the age levels specified in the documentation conflict with pupil materials, or the program itself. Consequently, the age levels and ability range of the software as assessed by the group is part of the evaluation procedure.

The use of micro computers in Geography is a growing phenomenon, but it is not the panacea for all ills. Poor teaching can equally well occur where use of the computer is made within the geography curriculum - the same is true of any other "tool" or methodology. However, integrated into a well balanced teaching syllabus where use is made of a wide variety of resources, where intended learning outcomes are stated, and evaluation applied, it can be highly successful, and engender powerful motivation.

The teaching context is therefore an important feature of any evaluation - geography teachers need to know where a piece of software will fit into an overall teaching strategy. It should not determine that strategy or curriculum, but be an integral part of it.

Any form of evaluation is to a degree subjective, although where a consensus view is taken, extreme viewpoints are often modified. Teachers appreciate an assessment of the programs quality, its flexibility in use, and the clarity of display particularly when modes of usage can vary from individual, to small group or whole class, the latter being probably least preferable where current geography software is concerned.

In conclusion, the format has proved successful and been readily adopted by those charged with the task of evaluating geography software. It is also easily managed, hopefully of immense use to those teachers who require an informed judgement of that software, and will form the basis of a regular feature contained within the ILEA Geography Bulletin, as evaluation of geographical software continues.

James Rouncefield:
Advisory Teacher for Geography

Note - see overleaf for a sample evaluation form

Editor
CAL EVALUATION SHEET - EXPLANATION

1. PROGRAM TITLE - published program title
2. PUBLISHER & SUPPLIER - name of publisher and supplier if different
3. ISBN - standard book number of software
4. AUTHOR(S) - surname and initials of authors
5. EDITION DATE - date of edition reviewed
6. COST - cost of edition reviewed
7. MACHINE - details of machine(s) for which program is available
   (RML only)
8. LANGUAGE - language in which program is written
9. MEMORY CAPACITY REQUIRED - minimum memory required to run program
10. MEDIA - disc or cassette; single density or double density
11. LOADING TIME - time required for program to load
12. COPYRIGHT - whether disc subject to copyright (yes or no); (many publishers allow making a copy for use; copyright usually waived on students' leaflets)
13. RUNNING TIME - minimum time required to effectively run program
14. HELP ROUTINE - is a help routine available during the program or at crucial times?
15. AGE LEVEL - the age range for which the software is considered to be appropriate
16. ABILITY - the ability range for which the software is considered to be appropriate
17. MODE OF USE - the use for which the software is e.g. demonstration, small group use, individual use
18. INSPECTION - is an inspection copy of the software available
19. RESULTS PRINT-OUT - has the program the capacity to print relevant data as a print-out?
20. AIMS AND OBJECTIVES OF THE PROGRAM - published aims and objectives of the program
21. PRIOR KNOWLEDGE REQUIRED - is any form of knowledge required or advisable before the program is run? What form does this take?
22. TEACHER'S GUIDE - an appraisal of the quality and guidance provided in the teacher's guide
23. STUDENTS' NOTES OR WORKSHEETS - an appraisal of the quality and guidance provided as students' notes or worksheets
24. TECHNICAL IMPLEMENTATION - what other provision or procedure is required before the program will run or operate, and how is this achieved?
25. TEACHING CONTEXT - the possible teaching contexts that the software could be incorporated into
26. PROGRAM QUALITY - a subjective view of the program's quality
27. CLARITY OF DISPLAY - how clear is the material shown on the VDU?
28. FLEXIBILITY IN USE - how flexible is the use of the program or parts of the program?
29. CONCLUSIONS - a general summary appraisal of the program. Is it recommended?
<table>
<thead>
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<th>AUTHOR(S)</th>
<th>EDITION DATE</th>
<th>COST</th>
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<td>ABILITY</td>
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<td>INSPECTION</td>
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<td>2. STUDENTS NOTES/WORKSHEETS</td>
<td>RESULTS PRINTOUT</td>
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<td>3. TECHNICAL IMPLEMENTATION</td>
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<td>CONCLUSIONS</td>
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<tr>
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<tr>
<td>Does the reading level appropriate? YES/NO</td>
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<td>Does the program work without difficulty? YES/NO</td>
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<td>Program Description</td>
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<td>Documentation:</td>
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Evaluator's name and contact address: ...
SOMERSET COUNTY COUNCIL

Program Evaluation Sheet - Evaluator's Notes

A GENERAL

1 It is very important, if not essential, that programs are assessed in the light of actual classroom experience with them, as unforeseen difficulties or benefits are often exposed when they are used with children.

2 Make your comments as concise and helpful as you can. If there is some important, overall impression given to you by the program, please say so clearly in the 'comments' section. Also say if there is another program which you know of which does the same thing better.

3 You are asked to put your name and contact address (usually your school address) at the end of the sheet and, therefore, may receive inquiries from other teachers regarding the program.

4 Please use a black pen, if possible, to aid photocopying.

5 It is hoped that the following notes will aid completion of those sections for which the intention is, perhaps, not clear. If in doubt, or having nothing worthwhile to say, please leave the section blank.

B NOTES ON COMPLETION OF EVALUATION SHEET

1 FILENAME refers to the (often abbreviated) name by which the program is "known" to the computer. Leave CODE and DEWEY NO blank.

2 Information to be entered in the COMPUTER and PROGRAM "boxes" should be factual (eg taken directly from documentation accompanying the program) and not opinion.

3 ASSESSMENT

(a) Curriculum level: circle the ages for which the program is applicable.

(b) Does the program work without difficulty? This does not refer to whether or not the program is difficult to use but to whether, for example, it loads and runs properly or whether it breaks down, displays inappropriate 'error' messages and requires reloading.

(c) What the program does: say what it actually does, not necessarily what the documentation says it does!

(d) Mode of use: refers to the possible ways in which the material may be used. For example, with a single pupil, a small group, as a classroom demonstration or as a game for two teams.

(e) Documentation: this refers to accompanying teachers' notes, their quality and comprehensiveness.

(f) Supporting materials: refers to additional reference material, etc which may be essential or advantageous but not necessarily provided with the software package.

(g) The reverse of the sheet is fairly clear; please use the 'comments' section as freely as you wish.
EVALUATION: Some Notes.

Best evaluation - classroom. Little work on this area. Principally I.T.M.A.

What makes a good package?
1. Interesting alternative to teaching strategies normally used.
2. Enrichment of existing topics.
3. New and useful additions to the curriculum.

Presentation - ability to cope with
1. Robustness - user mistakes.
2. Ease of use
3. Appropriate dialogue and pace
4. Support material
5. Flexibility
6. Friendliness

CONCLUSIONS

Did you enjoy it?
Did they enjoy it?
Did it promote useful activities?
Would you use it again?

Operation on black and white - colours red and dark blue, don't show up well.

CRASHING OF PROGRAMS

1. Caps Lock - operation upper & lower case - will it work on one only?
2. Values - try numbers out of range - what happens?
4. Arrow keys.
5. Press Return - is input checked or do you get a result?
6. Press any key - shouldn't crash.
Summary of key results of pupil program evaluation questionnaire

1. Enjoyment of programs:

- A great deal 30%
- No opinion either way 53%
- Did not enjoy programs 17%

2. Ease of use of programs:

- Easy to use 70%
- Some problems 26%
- Difficult to use 4%

3. Screen instructions:

- Easy to read 95%
- Difficult to read 5%

4. Graphics:

- Clear, comprehensible 79%
- Difficult/unclear at times 21%
- Confused & unclear 0%
5. View of help provided by computer with topic studied:

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<th>Help Provided</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>A great deal</td>
<td>9%</td>
</tr>
<tr>
<td>Of some help</td>
<td>59%</td>
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<tr>
<td>No real help</td>
<td>32%</td>
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6. Did CAL form a major part of work on a topic:

<table>
<thead>
<tr>
<th>About CAL</th>
<th>Percentage</th>
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<tbody>
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<td>Yes</td>
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<td>No</td>
<td>74%</td>
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7. Organisation of computer use:

<table>
<thead>
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<th>Organisation of Use</th>
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</tr>
<tr>
<td>Groups of pupils</td>
<td>70%</td>
</tr>
<tr>
<td>Teacher + pupils</td>
<td>15%</td>
</tr>
<tr>
<td>Teacher only</td>
<td>0%</td>
</tr>
</tbody>
</table>

8. Amount of 'hands-on' time:

<table>
<thead>
<tr>
<th>Hands-On Time</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 - 5 minutes</td>
<td>2%</td>
</tr>
<tr>
<td>6 - 10 minutes</td>
<td>17%</td>
</tr>
<tr>
<td>11 - 15 minutes</td>
<td>32%</td>
</tr>
<tr>
<td>Over 15 minutes</td>
<td>49%</td>
</tr>
</tbody>
</table>
9. Size of pupil user groups:

- 1 - 2: 40%
- 3 - 5: 57%
- Over 5: 3%

10. Use of package in pupils own time:

- Yes: 60%
- No: 40%

11. Would additional use of program aid understanding?

- Yes: 30%
- No: 70%

Addenda

b) Pupil Responses - breakdown by school and number

<table>
<thead>
<tr>
<th>Program</th>
<th>School</th>
<th>Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>BBC Introducing Geog</td>
<td>Heron Brook</td>
<td>7</td>
</tr>
<tr>
<td>EBC Advanced Geog</td>
<td>Aldershot Manor</td>
<td>1</td>
</tr>
<tr>
<td>Urban Growth</td>
<td>Portsmouth High</td>
<td>1</td>
</tr>
<tr>
<td>Micro-Mapping</td>
<td>Portsmouth High</td>
<td>5</td>
</tr>
<tr>
<td>Transport Networks</td>
<td>St John Rigby</td>
<td>2</td>
</tr>
<tr>
<td>Solar</td>
<td>Deal Sec</td>
<td>3</td>
</tr>
<tr>
<td>Solar</td>
<td>Testwood</td>
<td>2</td>
</tr>
<tr>
<td>Solar</td>
<td>Arnewood</td>
<td>2</td>
</tr>
<tr>
<td>Solar</td>
<td>Priestlands</td>
<td>2</td>
</tr>
<tr>
<td>Solar</td>
<td>Langley Park</td>
<td>1</td>
</tr>
<tr>
<td>Ice</td>
<td>Arnewood</td>
<td>2</td>
</tr>
<tr>
<td>Ice</td>
<td>Priestlands</td>
<td>2</td>
</tr>
<tr>
<td>Ice</td>
<td>Langley Park</td>
<td>1</td>
</tr>
<tr>
<td>Bearings</td>
<td>Aldershot Manor</td>
<td>2</td>
</tr>
<tr>
<td>QUEST</td>
<td>Onslow St Mary's</td>
<td>1</td>
</tr>
<tr>
<td>Census Database</td>
<td>Onslow St Mary's</td>
<td>2</td>
</tr>
<tr>
<td>NOHSM</td>
<td>Arnewood</td>
<td>2</td>
</tr>
<tr>
<td>NOHSM</td>
<td>Priestlands</td>
<td>2</td>
</tr>
<tr>
<td>NOHSM</td>
<td>Langley Park</td>
<td>1</td>
</tr>
<tr>
<td>SAKING</td>
<td>Arnewood</td>
<td>2</td>
</tr>
<tr>
<td>SAKING</td>
<td>Priestlands</td>
<td>2</td>
</tr>
<tr>
<td>SAKING</td>
<td>Langley Park</td>
<td>2</td>
</tr>
<tr>
<td>Water Budget</td>
<td>Testwood</td>
<td>4</td>
</tr>
<tr>
<td>Locks</td>
<td>Grayshott Primary</td>
<td>1</td>
</tr>
<tr>
<td>OS Quiz</td>
<td>Grayshott Primary</td>
<td>1</td>
</tr>
</tbody>
</table>
APPENDIX 4

DETAILS OF SOFTWARE NAMED IN THESIS

ROUTE  - motorway route planning simulation (Longman)
RICE   - simulation of problems of Indian rice farmer (Longman)
WINDS  - sailing ships game to assist knowledge of world wind
        systems. Partly gaming, partly tutorial in nature (Longman)
DEMOCR 1 & 2 - allows modelling of demographic data (Longman)
MORPHO - calculates statistics for drainage basin morphometry
        (Longman)
MAPSKILLS - GRIDREF teaches and tests 4 and 6 figure grid references
SCALES demonstrates different map scales. MAPSKILLS 2 is a tutorial
        program again for teaching compass bearings (Cambridge/Netherhall)
SEA CLIFF EROSION - simulated the erosion of a sea cliff, although
        the model is rather inaccurate (Cambridge/Netherhall)
EXPLORER - open ended exploration, actually an English program
        (Ladybird-Longman)
INHABITANT - sister program to EXPLORER and in the same style
        (Ladybird-Longman)
WORLDWISE - simple quiz on world capitals etc (Acornsoft)
HURKLE  - a very early coordinates game
SHEEP-DOG TRIAL - coordinates game (Jacaranda-Wiley)
MICRO-MAP -OS map work, tutorial style (Ladybird-Longman)
MICROMAPPING - OS map work (NELCAL)
GENERAL MAP READING - OS map work (Chalksoft)
QUEST/QUERY - powerful data base package (AUCBE)
INFORM    - powerful data base package (Nottingham)
CENSUS DATA-BASE - dedicated data base (NELCAL)
GEOBASE - dedicated data base for handling geographica data (Longman)
CLIMATE  - tutorial program for teaching world climate patterns.
        Criticised for its inaccuracy (Heinemann)
<table>
<thead>
<tr>
<th>Game Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>SETTLEMENTS</td>
<td>computer version of traditional settlement game (Hutchinson)</td>
</tr>
<tr>
<td>SAXONS</td>
<td>simple settlement game (MEP)</td>
</tr>
<tr>
<td>NOMSIM</td>
<td>simulation of nomadic pastoralists (listing)</td>
</tr>
<tr>
<td>TRANSPORT NETWORKS</td>
<td>simulation/game demonstrating development of transport networks in Third World country (Hutchinson)</td>
</tr>
<tr>
<td>SUMMIT</td>
<td>simulation of mountain climbing expedition (BBC)</td>
</tr>
<tr>
<td>RIVER</td>
<td>simulation (BBC)</td>
</tr>
<tr>
<td>ICE</td>
<td>simulation showing relationship of customer to retailer (unpublished)</td>
</tr>
<tr>
<td>SLICK</td>
<td>computer version of earlier game defending coast etc from oil pollution (BP)</td>
</tr>
<tr>
<td>SOLAR</td>
<td>electronic blackboard program showing changes in insolation for different surfaces and cloud covers (unpublished)</td>
</tr>
<tr>
<td>SWINDON</td>
<td>shopping simulation (BBC)</td>
</tr>
<tr>
<td>DERWENT</td>
<td>river simulation (BBC)</td>
</tr>
<tr>
<td>FLIGHT</td>
<td>simulation of air-route planning and other problems (BBC)</td>
</tr>
<tr>
<td>ECOSOFT</td>
<td>ecological simulation (Ed SCI Software)</td>
</tr>
<tr>
<td>TOURISM</td>
<td>simulation of tourist development in Third World (NELCAL)</td>
</tr>
<tr>
<td>WATER BUDGET</td>
<td>simulation of problems of irrigation farming (Hutchinson)</td>
</tr>
</tbody>
</table>
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