THE USE OF A MICROCOMPUTER IN THE PRIMARY SCHOOL

Russel Wills

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DECLARATION

I Alfred Russel Wills hereby certify that this thesis has been written by me, that it is the record of work carried out by me, and that it has not been submitted in any previous application for a higher degree.

Signature of Candidate ____________________

Date 1 Nov 1983

DECLARATION

I hereby certify that the candidate has fulfilled the conditions of the Resolution and Regulations appropriate to the degree of Master of Science (M.Sc.) of the University of St Andrews and that he is qualified to submit this thesis in application for that degree.

Signature of Supervisor ______ __

Professor A J Cole

Date 1/11/83

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Abstract

The current situation in primary schools is surveyed to set the scene for a discussion of the purpose, problems and possibilities of introducing microcomputers. Reasons are given for selecting the Commodore CBM/PET microcomputer and the implications of this selection. Due to the shortage of appropriate software a range of programs suitable for the primary school was developed. The philosophy of program design, overriding design aims and practical implications of the programs in areas of number reinforcement, language skills, geography, biology and logic games are explained. Evaluating the success of introducing the microcomputer is difficult since it is affected by a wide variety of factors including physical school environment; staff experience, training and attitude to integrating the computer into the classroom to add a new dimension to the school curriculum. The microcomputer hardware alone is not sufficient, suitable software and appropriate supporting services are essential.

Without exception the pupils reacted to the microcomputer with enthusiasm, enjoyment, and excitement and were highly motivated by it. In particular the younger and less able pupils seemed to benefit most.

Microcomputers will be introduced into primary schools and welcomed by the pupils, but will prompt a huge and increasingly sophisticated demand for computer related in-service training for the teachers.

CONTENTS

1. SURVEY OF PRIMARY EDUCATION

In order to set the scene for a discussion on the problems and possibilities of introducing microcomputers into the primary school it is necessary to survey the current situation in primary schools in Scotland. The bases for this survey are two reports by HM Inspectors of Schools in Scotland. The first is "Learning and Teaching in Primary 4 and Primary 7", HMSO 1980, in which the Inspectors surveyed 152 schools and examined the teaching of: language arts, environmental studies, mathematics, music, art and craft and physical education; and investigated assessment, methods of teaching and organisation. The other report is "The Education of Pupils with Learning Difficulties", HMSO 1978, for which HM Inspectors visited 140 primary schools. Both reports made a number of comments, conclusions and recommendations, many of which have a direct relevance to those persons interested in the possible areas of application of microcomputers to the primary school.

Looking at "Learning and Teaching in P4 and in P7" the Inspectors' conclusions include:

1. The typical Scottish Primary School makes pupils literate and numerate while not sufficiently recognising other fields of human experience and competency beyond these. The demands of this age, and of that to come, are for a capacity for independent thought, powers of deduction, and an ability to deal with change.

2. The teaching day is often divided into two parts, i.e. the basic skills and the rest of the curriculum. The basic skills of language and number are given the greatest importance and sustained attention, and standards in these basics have been maintained.
3. The daily programme is a matter of routine and the level of work undemanding.
4. There is an absence of activity and discovery learning, independent enquiry, deduction, open-ended questioning and small group discussion leading to opportunities to speculate, and offer tentative or alternative answers.
5. In the language arts the text book has been used as a syllabus, with the main emphasis on exercises in reading comprehension, grammar, language usage and spelling.
6. There is a lack of direct experience in environmental studies. Emphasis in environmental studies should be on the immediate school surroundings as a starting point for studies.
7. In mathematics there is a lack of practical work, and little consideration of the wide area of mathematics.

HM Inspectors suggest in the report:

1. The Primary curriculum should be broad.
2. That basic skills should be applied and practised within a wider curriculum since basic skills need a context.
3. There should be further extension of group and individual methods.
4. There must be a wide acceptance "active" learning for which grouping is essential, with more opportunity for small group discussion.

5. Collaboration ought to be possible in preparation and teaching across year groups.
6. There must be better provision of books for the less able readers who must be encouraged to use books.
7. There should be training in the use of reference books. Reference skills should be applied to practical situations.
8. Since too few demands were made on pupils' powers of invention and expression of ideas, provision should be made for regular and frequent experience of writing passages of the pupils' own composition. There must be a variety of ways of writing and of ways of improving thought and expression.

In their report on the "Education of Pupils with Learning Difficulties", HM Inspectors suggest throughout that appropriate rather than remedial education is required. It is necessary to ensure that:

1. Pupils are able to read, with understanding in a meaningful and stimulating context, showing skills beyond decoding. Difficulties with language arising in the teaching of concepts require to be dealt with as they arise.
2. The curriculum is differentiated to suit the needs of the child in content, pace, depth of study and methodology. The curriculum should be child based with no interference from the teacher, but intervention and help when necessary.
3. Regular diagnostic testing is given to all pupils. This ensures early identification of the onset of difficulty. All children have learning difficulties at some time over some topics, poorer children experience many more difficulties which tend to be compounded.

4. Pupils experience success. Success is essential to overcome apathy, and to this end the pupils' strong points and interests should be exploited so that there is a carry over of confidence from success in one area to other areas.
5. The methodology is appropriate. The work that is done must be done well with quality more important than quantity. There needs to be a variety of approaches including games.

6. Study skills are developed. Memorising is an art that can be encouraged, sitting and learning for a test has value. There are large bodies of necessary facts that have to be acquired.

2. INTRODUCTION OF MICROCOMPUTERS INTO THE PRIMARY SCHOOL

2.1 Background

Computers have arrived at their present ubiquitous state because they have become essential to the survival of our complex society. Our world suffers from so large an information overload that we cannot handle it unaided. As society becomes ever more complex the need for computers will continue and since the world needs them it will have them.

This need was first recognised by research staff mostly engaged on military projects but computers soon spread to industry and commerce despite their high costs and relatively unreliable components.

Universities have always been in the forefront designing and using computers. Schools meanwhile have not had sufficient finance to have their own computers and have relied on universities or industry to subsidise their computing endeavours.

Education authorities, as large scale employers, have widely used local authority computers for administrative purposes, particularly payroll, but have not generally made computing facilities available to schools.

Curriculum paper 6, known as the Bellis Report advocated the introduction of computer education into the Scottish School curriculum. The report proposed that it should not be a separate subject, but taught within each subject in the curriculum. Since teachers were not, in general, familiar with or interested in computers, only a few enthusiasts introduced computing into their curriculum.

The advent of the microprocessor, with considerable computing power, at a relatively low cost that schools could afford, was the springboard for computer studies in secondary schools. In 1980 a government initiative made money available for computer hardware in schools and colleges that could make a good case for being given a microcomputer. This provided a focus and incentive for other schools to get their own microcomputers from their own funds. The microcomputers that have entered secondary schools have often been used for administrative purposes. Since there has generally been only one microcomputer per school very few pupils, often only the sixth form, have had hands on experience. In England school examinations in computing science were introduced and the number of presentations is rapidly increasing. Scotland has been slower to introduce examinations, but trials for 'O' grade examinations are beginning.

So microcomputers have reached secondary schools where admittedly only a minority of pupils have access to them, but this is a start. The conditions for government support have often meant that inappropriate machines have been purchased for the tasks envisaged. The persons choosing the machines often having insufficient information, background and plans to make an informed decision. However a number of secondary schools are now using microcomputers efficiently with their pupils.

The question now arises whether microcomputers should be introduced into primary schools. A number of primary schools had already purchased, borrowed or been given a microcomputer as a result of some initiative by a computer oriented enthusiast before the Department of Industry initiated the Micros in Primary Schools Scheme. This scheme offered primary schools a choice from three selected packages, Research Machines 480Z, BBC Model B, or Sinclair Spectrum microcomputers together with appropriate colour or black and white monitor and tape cassette player, at half the normal price. This offer, while obviously providing a financial incentive to schools to get a microcomputer, was essentially a fillip for the British microcomputer manufacturing industry. These are not necessarily the best motives for introducing microcomputers into the primary school, but since they are being introduced it is appropriate to examine for what purposes they can be best be used.

2.2 Purpose

The main purpose of introducing microcomputers into the primary school is to give pupils a familiarity with the modern technology incorporated in microcomputers. Many pupils will be familiar with commercial leisure market devices and arcade games from non educational sources but will be unaware of other more useful applications of a non-entertainment nature. For the teacher the microcomputer can become a very flexible tool within the classroom helping in a great many ways, but requiring management and effort to utilise it to its fullest extent. The teacher too will become more aware of the capabilities of the new technology and be able to make rational judgements about the impact of the microcomputer on society in general and the pupil and teacher in the classroom. This awareness will help demystify the microcomputer and the claims made for it by some educationalists.

2.3 Potential Strengths

The greatest strength of the microcomputer in the primary school is the enthusiasm and enjoyment that it engenders in virtually all the pupils that use it. This enthusiasm generates a very positive attitude to whatever topic is programmed on the machine.

The individual components of a microcomputer, the keyboard, cassette deck and visual display unit are already familiar to most teachers and pupils from other contexts of typewriters, music centres and television. When linked or incorporated into a microcomputer they do not prove too complex to an interested user. The beginner whether pupil or teacher soon appreciates the simplicity and ease of using a microcomputer. The microcomputer mainly considered in this evaluation is the Commodore CBM model 3000 series, better although incorrectly known as the PET. With many machines in constant use over several years the CBM has proved to be robust and reliable in regular use in the primary classroom. The physical requirements are minimal, a single mains outlet socket to accept the 13 amp three pin plug, a sturdy table to rest the micro computer on and chairs for the pupils.

2.4 Problems and Weaknesses

Previous experiences with projectors, educational television and teaching machines suggest that technological innovations often have much less impact than their proponents had hoped. This has often resulted in the new devices gathering dust in cupboards soon after their introduction. There is an inhibiting force or human inertia working against the introduction of any new technique or working practice into any large organisation. This is also true in schools where the head teacher and promoted staff may not be prepared to make the effort to understand and evaluate new ideas, let alone make the commitment to introduce them. With this attitude from the promoted staff it is unrealistic to expect great commitment from the rest of the staff. Without a pressing commitment to introduce microcomputers other factors seem to compound the difficulties. Insurance of the equipment in school, at the enthusiast's home or in transit can be called into question or become problematic. There is teacher reluctance, the workload is already too high, to permit introduction of anything new, or involving any effort, especially out of school. Misinformation and prejudice lead to too high - it will make more teachers redundant - or too low - it is only for playing space invaders - an expectation of the likely effects of the introduction of a microcomputer.

The more knowledgeable and computer experienced teacher will point to the lack of programs. While there have been spectacular and well publicised advances in the hardware components this has not been matched by advances in programming, particularly in education, and a "software gap" has opened up. The better informed teacher is aware of this software gap, and the problems that it causes, realising that in the primary school the emphasis initially will be on using programs rather than writing them. These programs to be used by the pupils will need to be available if the microcomputer is to be properly utilised and its true potential fulfilled. This fact was recognised by the Microelectronics Education Programme which designed and produced the Micro Primer, a series of multi-media resource materials, to complement the Department of Industry's Micros in Primary Schools Scheme.

2.5 Management

The management of the microcomputer in the primary school classroom needs to be efficient yet unobtrusive.

1. Preparation

The arrival of the machine in the classroom should be carefully planned beforehand, and not just happen. The teacher must initially be convinced that she wants the microcomputer in the first place. This can best be established with an appropriate in-service training course. On the course the teacher is allowed individual access to a microcomputer and programs and taught how to use them both, overcoming any minor problems as they occur. Without pupils looking over her shoulder she is free to make deliberate, or other, errors and be shown how to correct or overcome these errors without embarrassment. While an in-service course can teach how to load and run programs a considerable time is needed to evaluate, even briefly, a number of programs for pupil use. This is best accomplished by allowing the teacher to take home the microcomputer and the programs to be evaluated, after initial program loading and running has been mastered. In any event the teacher must be familiar with the microcomputer and programs before it is introduced to her classroom.

2. Physical Location

The position of the microcomputer in the classroom is often determined solely by the position of the one and only mains electricity outlet. This is generally not in the optimal situation when other factors are taken into account. Behind the door and under the blackboard are the two most common and dangerous sites. The microcomputer needs to be set on a sturdy and rigid table or trolley, with space for cassette deck, printer if available, program storage and pupils' note and reference books. The pupils' chairs must be the correct height to reach comfortably the keyboard and see the screen without glare from the windows. The movement of the sun during the day may necessitate relocating the computer to avoid glare off the screen, or adjustment of the screen brightness. To avoid distracting the rest of the class the visual display unit should only be visible to pupils using it, and the teacher if she so chooses. It is apparent that the ideal location for the computer might require an extension cable from the mains outlet, if so it should be provided and positioned so that no one can trip over it.

3. Security

Depending upon the school's policy on security of valuable items of equipment the microcomputer should either be covered up, hidden or locked into a secure cupboard or safe each evening. If it can be wheeled on its trolley into such a location the effort and inconvenience is reduced to a minimum.

4. Maintenance

Routine maintenance should be minimal. The screen will need to be wiped at regular intervals to remove the residue from many grubby fingers pointing to particular information on the screen. The case will also need a wipe with a damp cloth to keep it clean. The cassette deck read and write heads should be cleaned, with an appropriate tape head cleaner fluid on a cotton swab, to remove any tape oxide particles every few months or when problems arise.

5. Scheduling

To get maximum benefit from the microcomputer each teacher needs to know when it is going to be in her classroom so that lessons can be fitted around the computer and computer programs prepared to fit into the scheme of work. Where there is only a single computer for a number of classes it should be timetabled as far in advance as possible so that it becomes an integral part of the sequence of work.

6. Development

Utilising ideas from the class teacher is the best way to achieve maximum teacher cooperation and involvement in developing the role of the microcomputer. This may involve releasing more teachers for "hands-on" in-service microcomputing courses or making time available for the "computer enthusiast" on the staff to prepare computer material for the other teachers.

7. Support

In-service courses can sometimes be arranged in the school during the day or after the pupils have been sent home early. This is suitable for introductory courses but the enthusiast will need detailed information, and more specific courses. Even with an "enthusiast" on the school staff easy access to an "expert" on computer education will often resolve apparently insoluble problems with a brief telephone call. The Micros in Primary Schools Scheme requires local education authorities to provide a minimum two day introductory course for staff of every school participating in the scheme.

3. Survey of Existing Educational Software

The amount of educational software available for microcomputers is expanding rapidly. The quality of this software, however, is extremely variable, and the price is not necessarily any indication of its merit.

Much of the new software is in the "public domain" which normally means it can be acquired for the price of the medium on which it is stored, or for nothing. On closer inspection the programs are often games with little educational merit, or "educational" with little programming expertise. These educational programs have often been developed by teachers for their own use in the classroom, and for the authors work reasonably well. Other users find it difficult to use the programs because the documentation is poor, the instructions on the screen are unclear and the wrong responses cause the program to abort. For these reasons programs in the "public domain" are often unsatisfactory. It is generally simpler to take any good ideas from the old program and write a completely new program around these ideas rather than try to improve the original.

There is however an increasing number of commercial sources of software for microcomputers which specialise in producing educational software rather than the all pervasive arcade games that the microcomputer manufacturers seem to think so important. (See Appendix 2)

Microelectronics Education Programme (MEP)

When the Micros in Primary Schools Scheme was announced in 1982 primary schools were offered selected hardware configurations at half price. Along with the hardware a Micro Primer self-study training package, compiled and produced by the Microelectronics Education Programme, is supplied. This package contains: a study text on all aspects of educational computing; a reader with a collection of articles to stimulate discussion and broaden attitudes; a system guide on how to set up the chosen microcomputer; classroom case studies with audio tapes illustrating how primary teachers have integrated the micro into their classroom; and software packs. The four software packs contain over 30 programs, each pack contains a number of programs on two cassettes together with a booklet describing each of the programs. Production of these was delayed, indicating the problems encountered in preparing and testing software for education by a specified deadline.

Micro Primer Software

The programs cover a wide range of different topics, pupil abilities, educational and programming style.

Brick up, Build, Eureka, More or Less and Trains are samples of the Micro Primer programs; each has comprehensive documentation including authors, equipment required, target age range, educational objectives, pre-requisites, a general description, detailed instructions on using the program and an annotated example of a sample run of the program. The versions reviewed here are for the BBC microcomputer.

BRICK UP is a dictionary game to practise spelling and expand pupil vocabulary. The teacher enters an initial starting difficulty and the pupil is then given instructions. This is in essence a spelling game, with the first two letters of the required answer given on the screen. If, for example the letters fi are given together with the clue "coming at the end", the required answer is "final". If the correct answer is keyed in the user gets a shot with a cannon at a brick wall. If an incorrect answer is given, say finish, another row of bricks is added and the correct answer is given. The aim is to knock a hole in the wall whereupon the game is over, congratulations are given and percentage of correct answers displayed. Consistent failure causes the user to be "bricked up", and the game is over.

Instructions are given in the documentation on changing the words and clues in the program. This is a very desirable feature allowing the teacher to adjust the difficulty for particular user groups.

This is a useful program, popular with teachers and pupils. However no scores are kept for the teacher to examine at the end of a session, and the real test is not of spelling but of manipulating the cannon to fire through gaps already existing in the wall. A brighter pupil could well manipulate his success rate so that he monopolises the machine. No time limit is incorporated. The graphics and text layout are good but a white background with red letters is rather trying on the eyes.

BUILD purports to be an open-ended game for use in mathematics, art and design. Perspective pictures of three dimensional objects are built up from cubes, which can be placed alongside, above, below, in front or behind those already present.

This program is a good example of a totally new activity, only possible with a computer with good resolution graphics. The use of this program is limited only by the imagination of the user. A simple screen to printer dump routine would, however, allow the user to capture his creations on hard copy for posterity.

MORE OR LESS aims to give practice in establishing the relationship between numbers and to reinforce the understanding of < less than, > greater than and = equals. The teacher chooses whether the pupil is to enter the correct sign or a correct digit, the number of questions to be given to each pupil and whether or not the intrusive sound effects are to be used. After entering his name the pupil is presented with an incomplete expression drawn in large crude white characters on a blue background. Inserting the correct sign or digit to complete the expression produces a "favourable" noise and message. An incorrect answer causes the sign to flash and then the background colour changes to red and the expression is corrected with reinforcing sounds and message. The teacher can see the scores for previous pupils or change the options by typing in SCORE or CHANGE instead of the next pupil name.

This is the type of program that teachers will be happy to use since it fits within the current curriculum frame work. It is marred by a few minor points, the poorly defined large size digits, the garish background colours used, the fact that the SPACE key is used to move on to the next frame is also on occasions interpreted as a zero and the inability to select a sound level between silence and excessively loud.

EUREKA is designed to enable the teacher to demonstrate and interpret features on simple sketch graphs and as a tool to promote and probe the pupils' understanding of graphs. This is a simulation program of running and taking a bath, particularly noting the level of the water in the bath. A picture of the current situation appears at the top of the screen, a graph of water level against time in the centre and messages explaining the last three commands at the bottom. The commands are on/off toggle switches, T to turn the tap on and off, P to put the plug in or take it out, M to put a man into bath or remove him from it and S to make him sing.

Like most simulation programs this program needs considerable preparation, both by teacher and pupils in order to obtain the maximum benefit when used in the classroom. Without proper preparation this versatile program will be seen as a fun program rather than a carefully designed educational tool. There is obviously no fixed or best way to use it, much depending on the imagination of the teacher. It is a pity that more use is not made of the sound capabilities of the computer by this program.

TRAINS is a drill and practice program for addition, subtraction and multiplication skills using numbers between 1 and 9999. The pupil can choose which rule to practise and then has to select the size of the number before the sign and then the size of the number after the sign. A random question within these parameters is then posed, a correct answer is rewarded by a number of green trains drawn across the top of the screen, wrong answers replace the green trains with blue ones. The aim is to complete a screenful of green trains. Each new question requires the pupil to specify the number of digits required.

While this program may be very motivating to the child it is most unsatisfactory from several points of view. The difficulty of the problem is often not related to the number of digits, and in any case it can be harder for the pupil to select an appropriate difficulty than to provide the answer. Pupils at the lower age ranges would have difficulty using the shift key to get +. No provision is made to correct or explain wrong answers! The documentation with this program anticipates some criticism, but this program is not up to the general standard of Micro Primer programs and should not have been included.

To summarise, the Micro Primer programs show a wide variety of uses for the microcomputer in the classroom, and in spite of the fact that the quality of ideas and programming is not uniformly high they provide a good basis for a primary school teacher starting computing in the classroom.

Scottish Microelectronics Development Programme (SMDP)

SMDP were slow to take an interest in primary schools but after the Micros in Primary Schools Scheme was announced they were obliged to become involved. By the Summer of 1983 they had made available, on the BBC Microcomputer, about half a dozen programs for remedial secondary school pupils that were also thought appropriate for primary schools, these include Decimal Defence, Table Worms and Word Invaders. Each program is supplied with three documents: Teacher's Notes, Technical Notes and Pupil's Notes.

DECIMAL DEFENCE gives practice in recognising decimal place value. The program starts with a simple title and cue screen, followed by a choice of one or two players, whose names are then entered. A three or four digit number, with or without a decimal point then appears on the screen, together with an instruction. e.g. underline the tenths. The underline is then moved using the cursor control keys until it is positioned as desired, and the space bar is pressed to indicate the task has been completed. If correctly underlined the word "correct" appears and the program moves on to the next question. Incorrect responses cause "wrong" to appear and a remedial sequence shows the correct answer. Four consecutive correct answers are rewarded by a game of starship control where a starship is guided through a galaxy of stars using the cursor control keys. This game continues until the starship collides with a star whereupon the pupil is returned to place value problems. A record is kept of the number of questions supplied and the number answered correctly.

The documentation, though extensive, adds little to what is seen on the screen. The program itself is of poor quality, making little use of the colour or sound facilities, the digits used in the questions are poorly defined and the error messages are not always relevant. Accidental double keystrokes on the space bar, to move on to the next question, cause an unwarranted error to be produced.

The pupils may well enjoy the game, but the educational value of this program is questionable.

TABLE WORMS is designed to motivate pupils to practise the multiplication tables. The title page with green text on dark blue background gives the cues required to run the program and see the scores. One or two players may use the program after they have entered their names. Each player starts with fifty "wood worms" on a table to be killed. A correct response kills one table worm and occasionally the pupil can play the game of blasting a cannon at the worms to kill some more. The pupil can choose which multiplication table to use, or let the program make the decision, and can then have a look at the selected table. The factor zero is always omitted from the table. Five random questions on the selected table are then presented for the pupil to answer, the responses are checked and RIGHT or WRONG is indicated. If all five are correct the pupil is given ten chances to shoot at the moving worms. Hitting them requires considerable hand eye coordination. Any mistakes cause remediation loops, after the series of five questions has been completed, with a large rectangle split into rows and columns representing the multiplication problem, presumably for the pupil to count the small boxes. The link up between the original error and the remedial loop is not obvious. When all fifty worms are killed the pupil's turn is over.

The game part of this program is much better programmed than the educational content which makes no meaningful use of colour or sound. The tables provided by the computer are random, which is not appropriate when the tables are of very different difficulty, and could be presented in a much more rational manner moving on to more difficult tables if correct answers are given and reverting to simpler ones if errors are made.

The use of the space bar to move on after every frame means the pupil can easily miss the final message, causing confusion and not assisting class management. The remediation loop is poor and at the wrong time. It should come immediately after the error is made.

WORD INVADERS aims to improve spelling by shooting out a question mark from within a word and replacing it with the correct letter. The game is based on the Space Invaders arcade game.

When run the program jumps straight into the pupil instructions, there is no title page or teacher notes on the screen and careful reading of the documentation is required to find out how to select the teacher options, which vary the speed, difficulty and noise level. Familiarity with the arcade game, or considerable explanation is necessary before a pupil will understand what is required of him. Shooting out the question mark requires good hand eye coordination and the ability to concentrate despite the continuous noises generated by the program. Having shot the question mark out it has to be replaced by the correct letter and here, when it is required, there is no audible warning of errors or encouragement of correct reponses. The program comes without any data, ready for teachers to insert their own appropriate data. A sample set of data is provided but the selection of words and clues is most inappropriate. e.g. ?AT, a feline and D?G, a canine. If the pupil cannot spell cat or dog he will certainly not understand feline or canine.

The technical expertise in the programming of the game playing section of this program is considerable. The use of the keys 1 and 3 however to move the "missile base" when the cursor direction keys are available, and the 1 key is adjacent to the ESCAPE key show that this program has been converted from some other machine with insufficient regard to the facilities of the new machine. A disproportionate effort has gone into the games element compared to the education element in this program, in fact the education element is almost ignored.

The games element in all the SMDP programs is well programmed and provides an effective motivation for pupils, if not teachers, to use the microcomputer, the documentation is pedantic rather than helpful with a number of errors and omissions but the overall impression given is of unsatisfactory educational content being grafted on to a good motivational idea. As a series the SMDP programs do not constitute a good introduction to educational computing in the primary school.

The software produced for this project is all for the monochrome Commodore CBM/PET but incorporates the motivational elements within the educational framework, not as an independent entity, and in topics that fit within the current primary school curriculum. The programs are designed to be easy to run and use, requiring no auxiliary documentation, even for a teacher with no previous computer experience.

4. HARDWARE AND ITS SOFTWARE IMPLICATIONS

4.1 Selection of Hardware

Since this project started there have been a number of significant technical and political developments that have affected the selection of microcomputers for the primary school. The most significant is the Department of Industry's Micros in Primary Schools Scheme which has effectively restricted the selection to three British manufactured machines.

The ideal microcomputer for primary schools would contain the following components as a basic minimum.

Keyboard, with full size moving keys, and cursor control, special and functions keys colour coded for ease of recognition;

Processor, with 64K of memory excluding the memory required for colour, animation, high resolution graphics and interchangeable character fonts;

Backing Storage, provided by plug in solid state storage, obviating the servicing and alignment problems associated with tape and disc drives;

Monitor, of medium size with colour, animation and high resolution graphics capability.

These basic components should be housed in a single, safe, light weight, easily handled unit with built in power supply avoiding any trailing connecting or power cables. Components should be easily exchangeable to ensure minimum delay for servicing and fault rectification.

This minimum configuration should be supplied at the lowest possible cost. Provision should also be made for simply adding other peripherals such as discs, printers, plotters, speech analysis and synthesis units, joysticks, control devices, and telesoftware adaptors as they become available or affordable.

Individuals or small groups of pupils could use the minimum configuration but for demonstrations to a class or larger group a large screen monitor would be essential.

The Department of Industry's Micros in Primary Schools Scheme provides a choice of six different packages - three different computers, each available with either a monochrome or a colour monitor. Each package includes a cassette recorder. The three computers are:

Sinclair ZX Spectrum

BBC Microcomputer, Model B

Research Machines Link 480Z

The Department of Industry provides half the cost of the system selected. The prices given below show the contribution required from the school in each case.

	Cost to Primary School	
	Monochrome	Colour
Sinclair ZX Spectrum	£173	£236
BBC Model B	£270	£325
Research Machines 480Z Link	£409	£461

All three computers have the central processor and keyboard housed in a single case with separate, comparable cassette tape players and colour monitors.

The initial appearance of the computers gives an obvious indication of their price. The 480Z is in a robust, damage proof metal case with a good quality standard QUERTY keyboard with a separate block of programmable keys. The BBC is in a rather flexible plastic case with colour coded control and programmable function keys. The Spectrum is very much smaller in a rigid plastic case with rubber keys in an idiosyncratic keyboard with a single keystroke facility for keywords but up to six distinct meanings per key using a variety of shift keys and modes.

The 480Z utilises a Z80A processor with 32K of memory, 29K free for user programs and data. The high resolution graphics system uses a separate memory giving good but rather slow graphics with six colours. There is no sound capability. The BBC incorporates a 6502 processor with 32K of memory which is reduced by up to 20K depending on the graphics mode selected. The high resolution graphics are faster, more flexible and provide more colours than the 480Z. Sound is also provided with controllable waveforms on four separate channels. The Spectrum also uses the Z80A processor with 48K of memory and provides simple graphics but with some colour interference within a single character position. Sound is provided with simple square waveform.

A wide variety of connections for RGB monitors, video, UHF, serial and parallel printers, networks and accessories, and a mains on/off switch are provided by the 480Z and BBC with the BBC also incorporating a disc drive interface. The Spectrum is much less sophisticated, with only UHF and user ports, requiring a special adaptor to connect to the RGB monitor.

The programming language provided, in ROM, in each machine is a dialect of BASIC. The BASICs in the BBC and the 480Z are comparable with a variety of input and graphics instructions. The BBC BASIC provides a much more structured language with IF...THEN...ELSE..., REPEAT...UNTIL... and PROCEDURE statements and the ability to incorporate assembler statements directly in a BASIC program. Spectrum BASIC checks the syntax before adding a statement to the program and allows the program to be changed without resetting all the variables.

Under the Micros in Primary Schools Scheme, which has been extended to run until March 1986, the schools are able to choose between these three British-made micros. The local education authorities have however often made the decision for the schools, some on the basis of proven reliability, and maintenance and chosen the 480Z, others have decided on the basis of economy and chosen the Spectrum. The great majority, around 70 per cent, have selected the BBC, as the compromise computer, in the hope that it will be reasonably reliable and in due course, have the widest range of available software.

The Commodore CBM/PET 3000 series of microcomputers was selected for this project because of its suitability for the primary school environment and its cost and availability in late 1979 when the decision was made. The only feasible alternative at that time was the Apple II microcomputer which was essentially disc based and cost three or four times as much as the CBM machines.

The chosen CBM/PET microcomputers have either 16K or 32K of random access memory, a 9 inch 40-column green screen and a large keyboard. The keyboard, monitor and printed circuit board are all housed in a single rigid plastic case with rubber support studs and sufficient weight to rest firmly on a desk or table.

Within this project the CBM/PET microcomputers have always been used in conjunction with the CBM C2N Datassette (cassette drive) and when using a printer it has always been a CBM 3022 (dot matrix tractor printer). These devices and their connecting cables are all properly matched and compatible, giving very few problems of communication between the peripherals and the microcomputer.

4.2 Selection of Programming Language

There are a number of different programming languages which have been developed for a variety of purposes. These languages vary in quality as well as purpose, and according to given criteria some are better than others. The best languages are not perfect and poor languages usually have their own particular strengths as well as weaknesses, so that they may, in certain situations be preferred to a generally better language.

Before starting to evaluate which programming language would be best for a particular purpose it is necessary to define fully what that purpose is. This all presupposes that there is a choice of language.

Once the decision was taken to use CBM/PET microcomputers the use of BASIC as the programming language was unavoidable. At that time only Commodore BASIC was implemented on the CBM microcomputer. Since then other programming languages such as Pascal and COMAL and the author language Pilot have been implemented on the CBM microcomputer together with a compiled version of BASIC, but in each case a disc drive is required for all practical purposes. The excessive cost of such a device, which was until recently only available in a dual drive format, made it totally impracticable for primary school use.

4.3 BASIC

The BASIC language is not the ideal language for programming computer assisted instruction packages. BASIC does not particularly encourage good programming practice nor is it especially self documenting but with careful and thoughtful programming these deficiencies can be considerably mitigated. The main purpose of this project is not however in the realm of computer education, i.e. teaching programming, systems analysis etc., but in computer assisted learning, i.e. using the computer as a tool to assist the teacher in the teaching or reinforcing of a variety of subjects within the primary school curriculum.

Interpreted BASIC tends to be rather slow in execution, but in the programs in this project speed is not normally critical. On the contrary time delays are often incorporated to slow down the execution of the programs to a speed appropriate for the pupil. Only in some of the word processing applications, when single key presses are instigating considerable string manipulations, are there any appreciable delays between the key press and the resulting action.

Data structures in BASIC are limited to arrays of strings and numeric variables; control facilities are poor with only FOR...NEXT, IF...THEN..., GOTO and GOSUB and the inability to label instructions; text handling is clumsy; and file handling, with only magnetic cassette files, is primitive. Despite these deficiencies BASIC proved to be adequate for the tasks in hand.

BASIC is not a language that was fully defined first and then implemented later, rather it is like FORTRAN attempting to reach a standard after years of use in various differing implementations on a variety of machines. Each manufacturer including its own particular additions to BASIC to make best use of its own specific hardware facilities.

4.4 Commodore BASIC

Commodore BASIC is resident in read only memory, ROM, avoiding the need for it to be loaded into memory before use. A second or so after the CBM/PET is switched on a message on the screen says "Commodore Basic", how many bytes, or characters of memory are available and "READY" followed by the winking cursor as a prompt.

Entering a program in Commodore BASIC is simple on the robust, full size keyboard. Each program statement may take up to two full lines on the screen. Most of the keywords can be abbreviated to their first letter and shifted second letter. Screen editing is facilitated by special keys, so mis-typing and programming errors can be simply and quickly corrected.

Variables are of three types: numeric, integer and string, and may be subscripted. Variable names must start with a letter and may be followed by a letter or digit. Further letters are valid but are not considered part of the name so SCORE and SCHOOL are legitimate variable names but both could be replaced by SC and if this is not recognised would give surprising results.

Commodore BASIC has particularly idiosyncratic graphics. When first switched on the CBM/PET is in its upper case/graphics mode and all BASIC keywords are in upper case, produced without using the shift key. Using the shift key a variety of symbols, shapes and graphics can be produced. The symbols for spade, heart, club and diamond betray the CBM/PET's origins in the leisure and home entertainment markets. These graphics characters can, with a little ingenuity, be used to produce pictures, faces, maps and diagrams, both static and animated.

An unfortunate drawback to this system is the loss of many of the graphics characters when the screen mode is changed from upper case/graphics to lower case/upper case. This is particularly relevant in the primary school where upper and lower case letters are often essential and good graphics desirable.

Switching between modes is achieved using the POKE instruction, which is also used with PEEK to obtain visual effects on the memory mapped screen.

The PRINT statement in Commodore BASIC requires some care when tabulating numbers since it is essentially aligned from the left hand margin, while children are taught that numbers are aligned from the right with each column of digits having a particular place value.

All programs were developed on a CBM/PET with the BASIC Programmer's Toolkit, a machine language program provided in a two kilobyte read only memory chip, installed. This provided a number of useful extra faclities not otherwise available in Commodore BASIC, e.g.:-

AUTO provides new line numbers when entering BASIC program lines;

RENUMBER to completely renumber program lines and GOTO and GOSUB references;

FIND, DUMP, HELP, TRACE and STEP to assist in detecting obstinate program errors and

APPEND for adding previously SAVEd programs or subroutines to the one currently in the computer.

4.5 Portability of Software

All the software developed in this project will run on any unmodified 3000 or 4000 series CBM/PET microcomputer, with at least 16K of memory. To retain this broad portability all special equipment and customised ROM chips were avoided. The BASIC Programmer's Toolkit was used in program development, but need not be installed for program execution.

Other microcomputers, such as the Apple II, have a much greater variety of memory size and range of plug in and add on components so that software developed for one microcomputer system often does not work on another for reasons of machine incompatibility.

To permit straightforward transferability of programs from one make of microcomputer to any other it would be necessary to restrict the instructions used in the programming to that subset common to all the machines. This would restrict the programmer in different ways on different machines according to the implementation of BASIC and detract from the value of the program. Transfer of the project programs from CBM/PET to other microcomputers would not be simple since in order to make the most of the CBM/PET hardware many of the uniquely Commodore BASIC facilities are used extensively, including the idiosyncratic graphics. Conversion of programs with such features would involve a complete reassessment of the graphics content in the light of the graphics facilities provided on the target computer.

5. Software Project

5.1 Philosophy of Program Design

Innovation is difficult in education. In order to stand any chance of introducing microcomputers into the primary school they must be seen by the teachers to have value and be easy to use, both by themselves to set up, and by their pupils in everyday use. Hence value and ease of use are two of the prime design aims. From the teacher's point of view this means the programs must be simple to load from the selected cassette into the computer's memory, and having been reliably loaded then be flexible enough to cope with the diversity of teacher aptitude and pupil ability. The essential feature then becomes a simple robust user interface, so that no matter which keys are pressed accidentally, erroneously or on purpose an appropriate, informative error, warning or rewarding message is given and the program continues without interruption.

There is always a balance between cost and facilities provided by any computer hardware. Having chosen cassette based microcomputers for this project, since this would put them in an affordable price range for most primary schools, it is necessary to ensure that the time taken to load the program into the machine is utilised to the full. To attain this flexibility whereby the program, once loaded, is as adaptable as possible for use by the largest number of pupils of the widest range of abilities a variety of options are given to the teacher before each group of pupils use the machine. These options include the total time for each pupil, the computer providing an impartial timekeeper and avoiding arguments over allocation to each pupil; the starting difficulty or complexity whereby the better groups of pupils do not have to work through all the simplest stages before reaching material suited to their ability; and topic say addition or addition and subtraction rather than multiplication and division. This flexibility is "bought" at some increase in program length, but gives an overall gain in program utility.

A large portion of a primary teacher's effort is spent on routine low grade work, such as preparation of workcards and marking reinforcement exercises. With the microcomputer it is possible to remove much of this uninteresting work from the teacher. With a printer attached even more can be done for the teacher in assessment and record keeping. To do this the programs ask the teacher if a printer is available and output results to it if appropriate. This allows regular assessment of all pupils with the minimum of teacher effort and identifies immediately any pupils that are falling behind, as suggested by HMIs in their reports.

Working at an inappropriate pace is one of the factors that induces stress in pupils. All the programs in this project move at the pace of the pupil, no matter whether that pace is faster or slower than the average. Thus the better pupil can race ahead with the program, while a slower pupil will cover the same ground at his own pace, the quality of response being more important than the quantity. With these programs the slower readers are not penalised and discouraged by unfair competition with the others.

To recapitulate the design aims are:

1. Value

The prime aim with all programs in this project is that they should have educational value in the classroom. They should achieve their objective better, more simply or more effectively than by other methods. This rules out many topics of an open ended or discussion nature where the good teacher will always be supreme.

2. Ease and Comfort of Use

Both teacher and pupil should be able to use the programs with confidence and enjoyment at their own pace. Mistakes in typing should be easily corrected after an appropriate message, and the program continue.

3. Flexibility

Since it takes a while to load, maximum use must be made of the program once loaded. Hence flexibility, whereby the teacher can adjust the program to suit the various abilities of the pupils is most useful.

4. Clarity of Presentation

The main channel of communication between the microcomputer and the teacher and pupil is the screen so for best results the screen layout is most important. Careful consideration must be given to readability and clarity of instructions and data within the limits of the screen.

5. Reliability

Programs must not "crash" when inappropriate data is entered. Unreliability destroys confidence in both pupil and teacher, leading to frustration, annoyance and avoidance of the computer.

6. <u>Reusability</u>

To retain incentive and interest, when a pupil returns to a program for further reinforcement, the programs should be randomised so a different sequence of problems are posed each time within the appropriate difficulty level.

7. <u>Utility</u>

The computer has great potential utility in certain areas and each program should attempt to maximise this potential. The addition of a printer, whereby with no extra effort the teacher can get a printed, headed and dated list of pupil results, is an example of this utility.

5.2 Program Standards (User View)

Whenever possible a uniform approach has been made to similar situations in all the different types of program. By standardising layout and responses the users rapidly become familiar with new programs since most of the responses are similar to those already met in earlier programs.

The standard features include the following.

1. Distinctive "Front Page" with program title and authors or instigators.
2. "Press C to continue" to move on to next frame. This permits the program to be loaded and run in preparation for a class or group of pupils. Together with the "Front Page" this will hold the program at the beginning until the user is ready to start. The alternative of a built in timed delay would allow the program to continue beyond the front page, so a late comer would have missed the title page. The use of "Press C to continue" within the program allows the slow reader to take as much time as necessary to read any preliminary instructions and information. Thus the pupil can proceed at his own best pace, without stress. When particular instructions have been understood they need not be read and the teacher or pupil is able to continue immediately by touching the C key. The "C" key was chosen in preference to "any key" because "any key" includes the RUN/STOP key which would in fact interrupt the program. Earlier programs used "Press SPACE to continue" when

SPACE was actually inscribed on the space bar, but the newer keyboards do not identify the space bar. In practice even "non-readers" are able to press "C" to continue to move on to their next non literary task.

3. Teacher Notes

After continuing from the "Front Page" the programs normally move on to the Teacher Notes page or pages depending on the number of variables that the teacher has to select. The teacher notes give a brief introduction to the program. In many ways this is preferable to detailed documentary notes on the program which tend to become separated from the program, and progressively out-of-date as various amendments and improvements are made to the program. After the introduction the teacher is asked if there is a printer available and for the particular level, time per pupil, layout and difficulty for the next group of pupils. Where there may be some doubt, appropriate responses are suggested. Whenever possible the response is checked for reasonableness, and if the response is deemed unreasonable the question is repeated. If a printer is available the program requests the date and this is stored for later output onto the printer when the results of the pupils efforts are printed. This proves invaluable for filing sheets of results for later analysis.

4. Pupil Notes

These appear after the "Press C to continue" at the end of the teacher notes, and for each new pupil. Each pupil is first asked for his name, which is stored for later recall with results or analysis of responses, and then welcomed to the particular program in a friendly and informal way. The pupils particularly like this approach and tend to treat the computer as a "friend", even talking to it. The task before the pupil is then explained. Instructions are made as simple as possible but have to be commensurate with the task to be undertaken. There must be no doubt in the pupil's mind about what he has to do next. This does not preclude the teacher explaining to the class as a whole what the program is about and how it works. This is particularly true for poor or non-readers who when the task is explained beforehand may well be able to attempt it without being able to read the detailed instructions. With the motivation provided by the microcomputer itself it is remarkable what the pupils are able to achieve. When the "handshake" is made and the instructions are completed pressing "C" moves on to the Program Start.

5. Program Start

This is when the program comes under pupil control. The particular task is set up and the pupil must respond in his own time. The dialogue between pupil and program may take differing forms depending on the complexity of the task. For the very young pupils a tick indicates a correct answer and a cross a wrong response. These signs are well known and recognised and do not require "reading" to interpret. Three successive wrong answers cause the correct answer to appear. A press "C" to continue is needed to move on to the next task, giving the pupil as much time as he needs to examine the correct answer.

6. Time Up

When the time allocated by the teacher for each pupil has elapsed the pupil is allowed to finish the task on hand. When complete the pupil is informed that his time is up and instead of a new task an analysis of his performance is given. The option is then given to look at the results, or set the program ready for the next pupil. The teacher can then see how all the pupils in the group so far have performed with a display on the screen, and a printout, with the date, if a printer is available.

7. Results

After each pupil has finished his allotted time the teacher, or pupil, has the option of looking at the results on the screen for all the pupils in the group to have used the program so far. If a printer is available the results are printed out, together with appropriate headings and the date, for easy filing.

After displaying the results the program gives the option of continuing with more pupils in the same group, starting again with a new set of teacher options or ending the program run completely.

5.3 Program Standards (Internal)

The user interface between the teacher or pupil and the program has been made as simple as possible from the user point of view. The simplicity is not reflected in the programming which at all times attempts to prevent invalid input entering the system.

No key, other than the RUN/STOP key, should interrupt the program even if incorrect or inappropriate. The exception of the RUN/STOP key is to allow the teacher to stop and change or restart the program at any time. The use of this facility outweighs the advantages of disabling the RUN/STOP key so that no-one can STOP the program at any time without switching off at the mains.

Wherever possible single key responses are used, with the GET instruction rather than INPUT which requires the RETURN key to be pressed to complete the response. Obviously this is not possible when for example a pupil is entering his name, but in this case a prominent message reminding him to press RETURN is displayed. Failure to press the RETURN key is a major cause of pupil complaints that the computer is "not working". Single key press responses reduce this problem.

If the pupil response is unreasonable or outside the range of expected replies the response is either ignored or an appropriate message is given and the response requested again. Rubbish data is refused entry to the system.

If the pupil gets a task wrong a helpful message is given wherever possible. The extent of this message depends on the screen layout for the task in hand. Three successive wrong answers to a single task usually cause the correct answer to appear. When the pupil has examined the right answer he can continue to the next task.

To keep the screen uncluttered optional paging facilities allow the pupil to return to diagrams, maps or timetables as required.

Within the program all non-standard access to system variables has been avoided. This has paid dividends as different versions of the microcomputer have been introduced, with different system locations.

Widespread use of subroutines has been made to reduce the size of programs to a minimum, and to facilitate the construction of new programs.

5.4 Programs

The programs in this project fall into five major areas. Arithmetic reinforcement and language fundamentals where teachers can readily see the benefits of the programs for all their pupils, particularly those in need of an added incentive to get sufficient reinforcement of basic ideas.

Geographical and biological programs cover topics that the teachers might not normally cover, while the mathematics puzzles and logic games stretch the more able pupils.

The diagrams of the screen layouts given below are printed on an 8 x 6 dot matrix character printer and do not exactly represent the 8 x 8 dot matrix character on the screen, consequently the reverse video characters are not printed as clearly as they appear on the screen.

5.4.1 Arithmetic Reinforcement

Reinforcement of simple arithmetic processes is the easiest topic to program on a microcomputer. The aim must be to make the format as interesting and challenging as possible for the ability of the pupils concerned.

Count

A number of similar objects, ships, dogs, faces, houses etc. appear on the screen and the pupil has to count them and type the number of them on the keyboard. The number typed appears in oversize digits on the screen. If correct a large tick appears. Three successive incorrect answers produce a cross and then the correct answer is supplied.

Even preschool children enjoy this program, since after watching someone else using it, and knowing their digits up to say five, they can successfully use it, even if unable to read.

C o u n t i n g   t o   2 0

Ann & Russel Wills

Press C to continue

Teacher's Notes

This is NOT a teaching program.
This program is designed to give
practice in counting up to twenty.

You decide the difficulty and time
that each pupil gets. Results are
stored for up to twenty pupils.

Do you have a printer attached, plugged in
and switched on? (Press Y-yes N-no) N

Press C to continue

Teacher's Notes (cont)

What range of numbers do you want
your pupils to count?

1	numbers	1	to	5
2	numbers	1	to	10
3	numbers	10	to	20
4	numbers	1	to	20
5	numbers	0	to	20

Select 1, 2, 3, 4 or 5 : 2

Press C to continue

Teacher's Notes (cont)

How many seconds for each pupil.
Type the number then press RETURN key.
200

Press C to continue

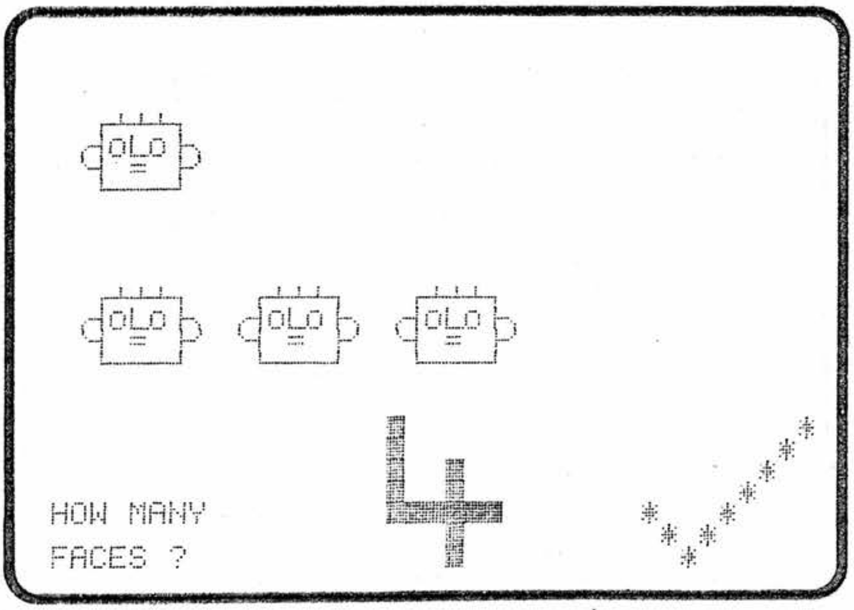
Pupil's Notes

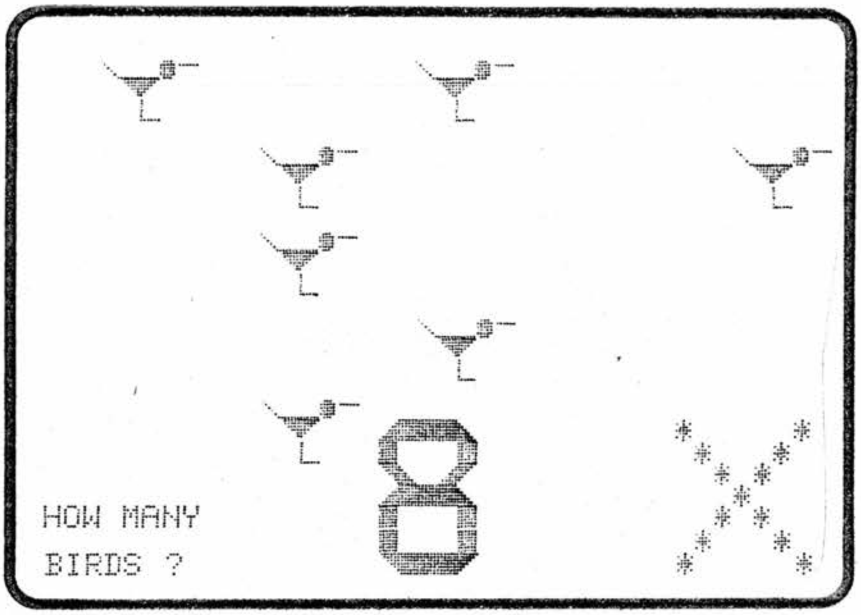
Please type your name on my keyboard
then press the RETURN key.
Tom

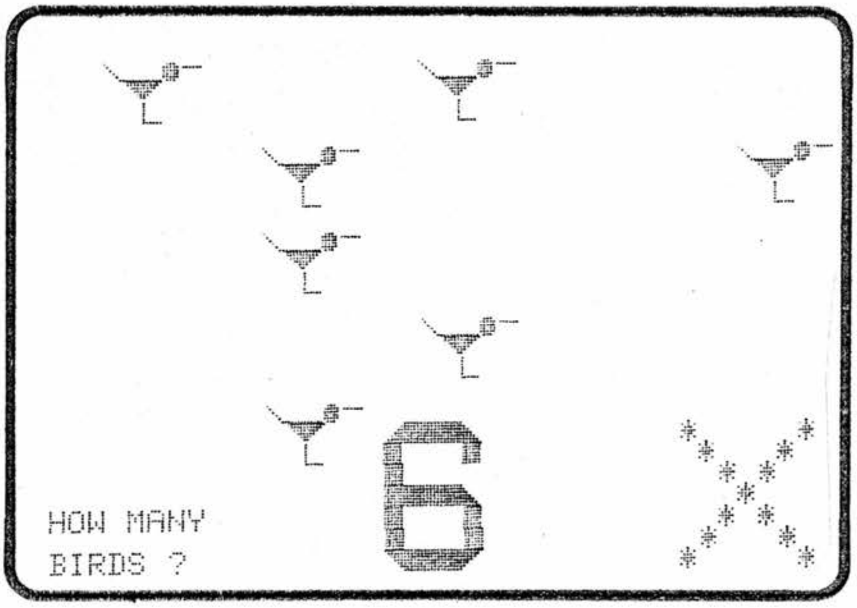
Hello Tom,
I am going to give you some things
to count.

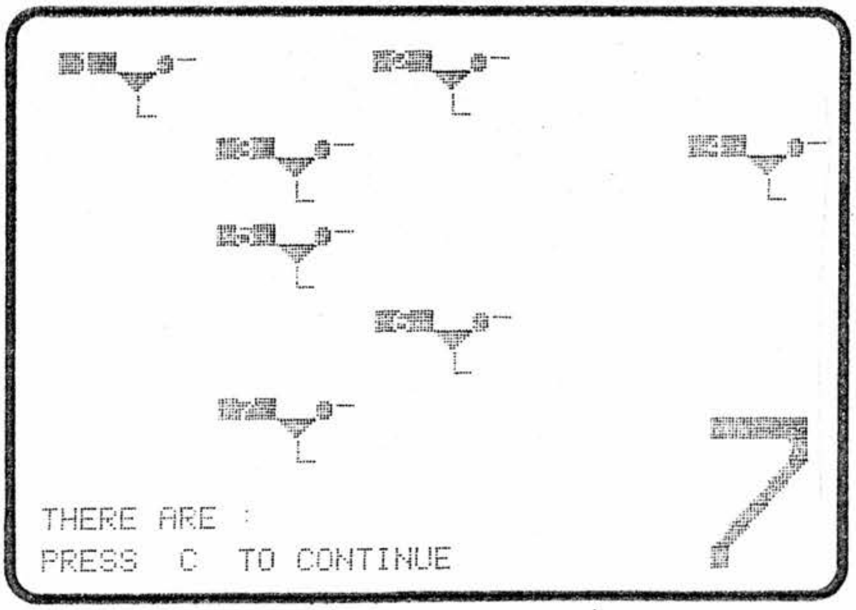
Good luck.

Press C to continue




HOW MANY
BIRDS ?
8


HOW MANY
BIRDS ?
6


THERE ARE :
PRESS C TO CONTINUE
7

```
Your time is up, Tom

You got   0  sets correct.

You made  3  mistakes.

You took  133  seconds.

Press  P  for next pupil
   or  R  for results.
```

```
R E S U L T S   Counting   Max num= 15

Num  Name (Time= 60 secs.)   Right Wrong

 1   Miriam                  2     0
 2   Jonathan                3     0
 3   Martyn                  4     0
 4   Tom                     0     3



Press P for next pupil,  R for results,

      S to start again   or   E to end.
```

```
This is the end of

Counting to 20

Goodbye.


ready.
```

Multiplication Square

Learning their tables is not an attractive proposition for most pupils. This program provides an encouraging environment to practise multiplication tables. The teacher sets the maximum table and time for each pupil. The screen is then set up with the requested format and the random numbers to be multiplied flash, together with the location for the answer. If the correct answer is typed it is inserted in the correct location and another pair of random numbers immediately begin to flash. The timing of the flashing seems to invite the pupil to hurry on and get his best score. Three wrong answers cause the correct answer to be inserted in reverse mode so the teacher can see the errors on the screen as well as on the results listing.

Balance with Addition and Subtraction

This program simulates putting numbers on a balance, the pupil has to make the numbers balance, by putting equal numbers on each side. The teacher controls the layout of the equation, whether it is an addition or a subtraction problem, the difficulty, and the time of the practice for each pupil.

After the pupil hand shake a diagram of a balance appears on the screen, with a winking cursor to indicate where the answer is required. Correct answers leave the balance horizontal and the pupil is rewarded with a large tick. Incorrect answers cause the balance to tip in the appropriate direction and a large cross to appear. Successive wrong answers bring up the correct equation. When his time is up the pupil's score is displayed.

B a l a n c e
with
A d d i t i o n
and
S u b t r a c t i o n

Ann & Russel Wills

Press C to continue

Teacher's Notes

This program is designed to give practice in number bonds up to twenty. You decide on the question layout, difficulty and time that should be given to pupils for answering a number of questions.

Do you have printer attached, plugged in and switched on? (Press Y-yes N-no) N

Press C to continue

Teacher's Notes (cont)

What layout do you want ?

For $x \pm y = \square$ type 1

$x \pm \square = z$ type 2

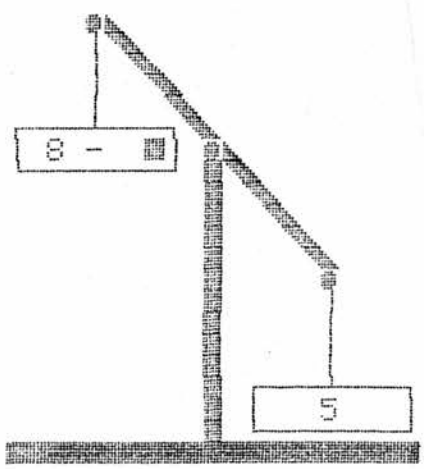
for mixture of 1 and 2 type 3

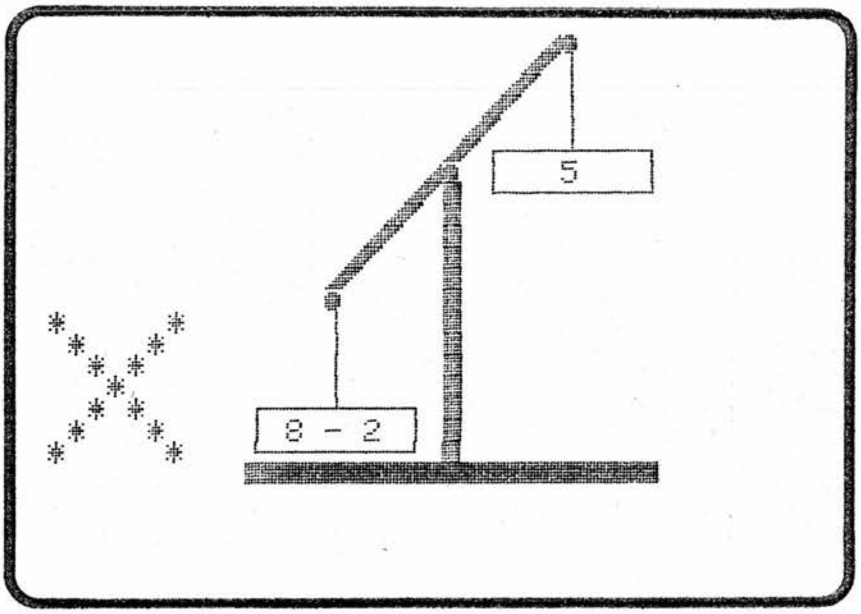
$\square \pm y = z$ type 4

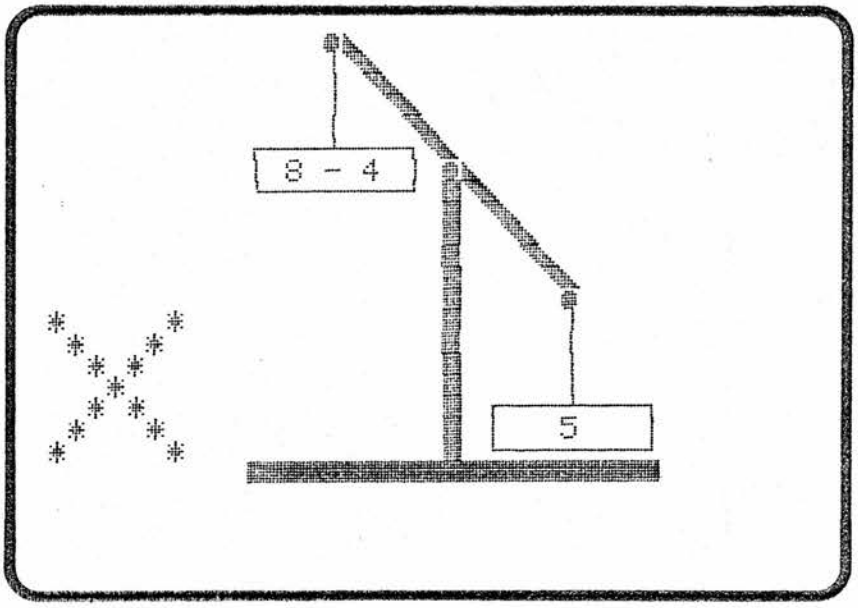
for mixture of all above type 5 2

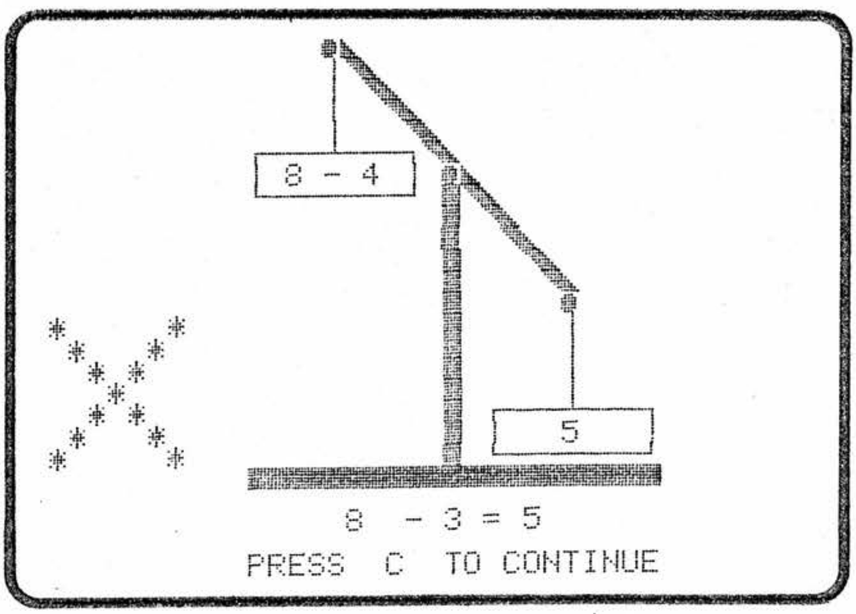
```
Teacher's  Notes (cont)
Type + for addition, - for subtraction
or  B for both addition and subtraction
What kind do you want ?  B

Specify the bond you want(20 max). Type
the number then press RETURN key : 20

For random bonds up to 20 type  R
for all bonds fixed at 20 type  F : R

How many seconds for each pupil.
Type the number then press RETURN key.
100
          Press  C  to continue
```

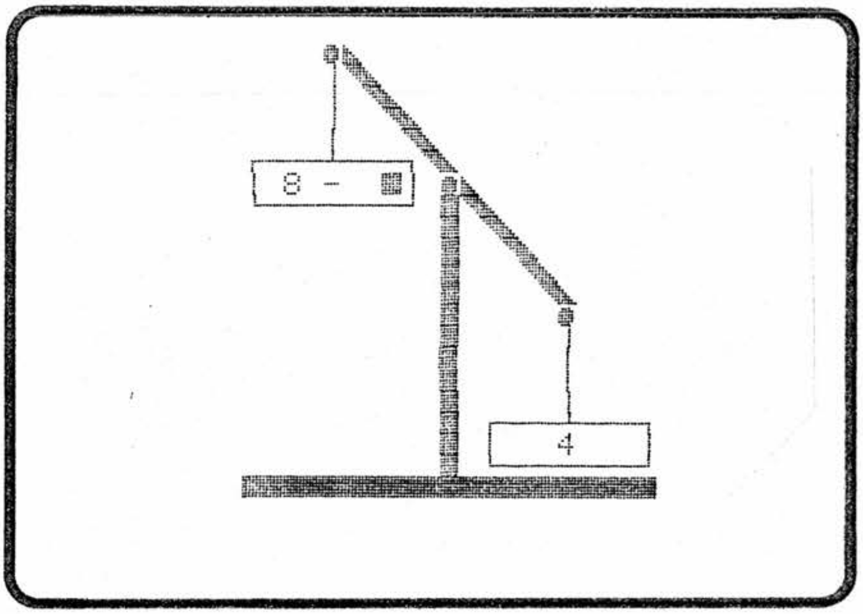
```
Pupil's Notes

Please type your name on my keyboard
then press the RETURN key.
Miriam

Hello Miriam,
I am going to give you some boxes
to fill in.

Good luck.


          Press  C  to continue
```

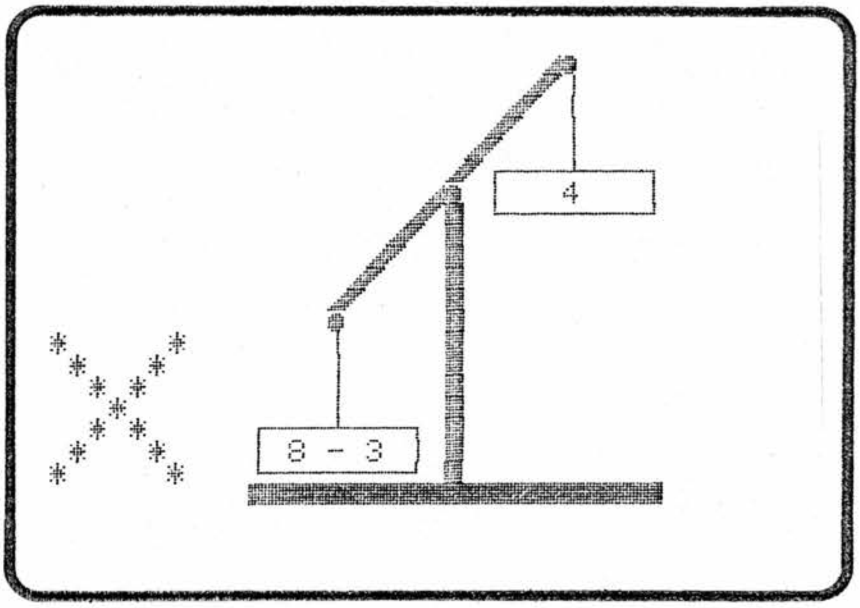


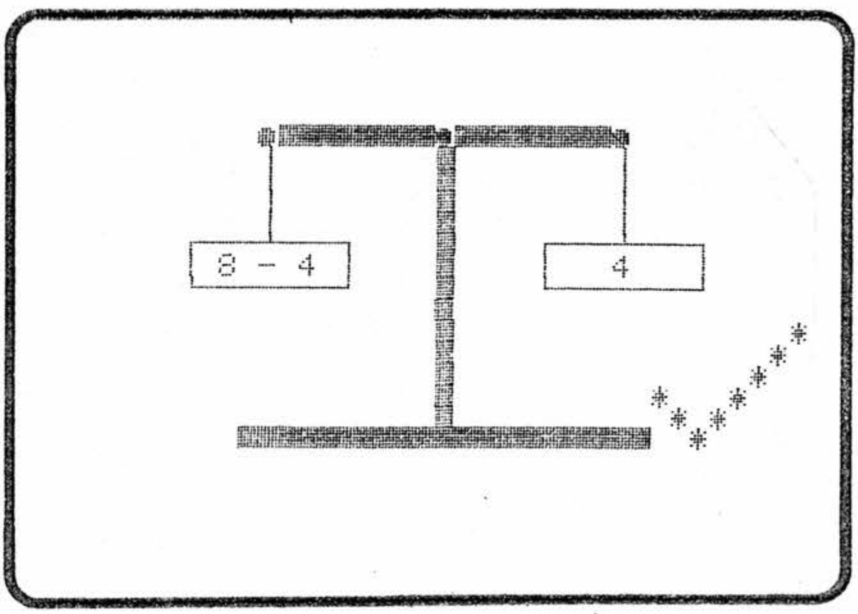

5
8 - 2


8 - 4
5


8 - 4
5
8 - 3 = 5
PRESS C TO CONTINUE


8 - ■
4


4
8 - 3


8 - 4
4

```
Your time is up, Martyn

You got   8  facts correct.

You made  2  mistakes.

You took  210  seconds.

Press  P  for next pupil
   or  R  for results.
```

```
R E S U L T S  HB= 20  Layout= 2  R/F=R
Num  Name (Time= 100 secs.)  Right Wrong
 1   Jonathan                2     3
 2   Miriam                  10    0
 3   Martyn                  8     2









Press P for next pupil,  R for results,
     S to start again   or   E to end.
```

```
This is the end of

Balance Add / Subtract.

Goodbye.
ready.
```

5.4.2 Language

Open ended language work on the microcomputer is difficult if not impossible to program. There are however some fundamental skills associated with language that can more easily be programmed. Alphabetic order of letters and words, vital for reference skills and dictionary use come into this category. Sequencing words and sentences to make sense involve more complicated skills and the understanding of what has been read.

Sort Letters and Sort Words

These programs reinforce the concept of alphabetical order. The teacher decides if the pupil is given the alphabet at the top of the screen, the starting difficulty and time for each pupil.

The pupil is then presented with a series of letters or words which have to be selected in alphabetical order. Large ticks or crosses indicate progress or otherwise, the correct answers are inserted if three successive incorrect replies are made. To avoid excessive time hunting over the keyboard for the letters of the words, a single digit is typed to indicate which word is required. This permits more time to be spent on the actual sorting task that is the object of the exercise. Keyboard knowledge and dexterity is important, and is developed with SORT LETTERS.

Word Sequencing

The words of a sentence are scrambled up by this program and the pupil has to move them back into their correct order. To do this he has to read the words and decide in which order they should appear. Capital letters and punctuation may provide some clues to assist him. To move the words the pupil has to develop and use word processing skills, manipulating the cursor and words, without actually typing the sentence. To indicate he has completed the sentence he presses the full stop, reinforcing punctuation practice. If correct a new sentence appears, otherwise the cursor returns. When time runs out the last sentence is automatically corrected.

Sentence Sequencing

A number of sentences, with an inherent logical sequence, are mixed up on the screen. The pupil has to use the word processing skills developed in Word Sequencing to put the sentences into their correct logical order. In both Word Sequencing and Sentence Sequencing programs it is a relatively simple task for the teacher to enter her own sentences to suit particular groups or individual pupils.

5.4.3 Geography

The old and familiar game of hangman provides a most suitable format for this quiz on various features in Angus.

The program starts with a full screen map of Angus using the extensive range of the computer's character graphics. Hills, lochs, rivers and coast are clearly displayed. The user is then given a choice of the features that are to be investigated, this includes towns, coastal features, glens, rivers and lochs. When the selection has been made the map returns to the screen and a winking asterisk indicates the location of the feature to be identified. The hangman format replaces the map, and the number of letters in the answer are indicated. Correct letters are inserted, incorrect ones cause the hangman's gibbet and victim to appear.

The letters used are also recorded so that the teacher can

H A N G M A N

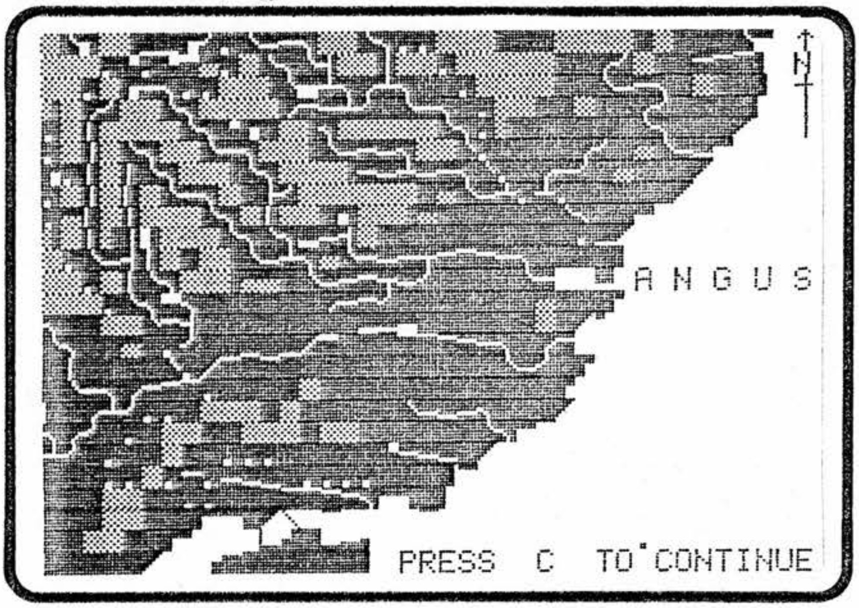
ON PLACES IN

A N G U S

B Y

RUSSEL WILLS

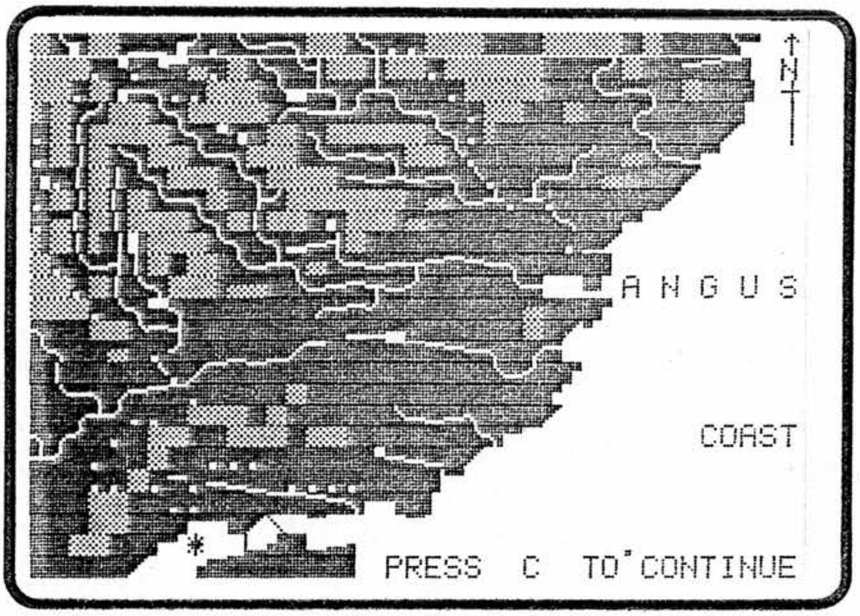
PRESS C TO CONTINUE

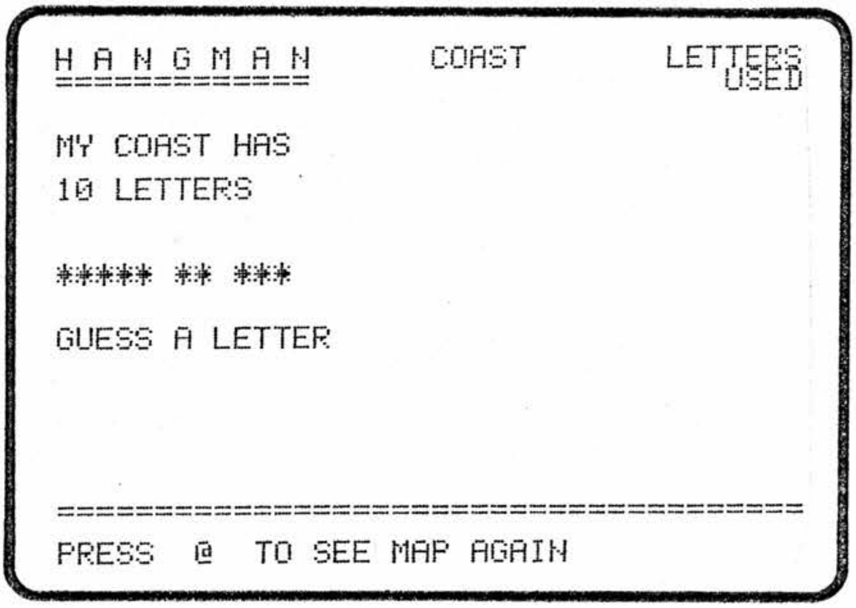


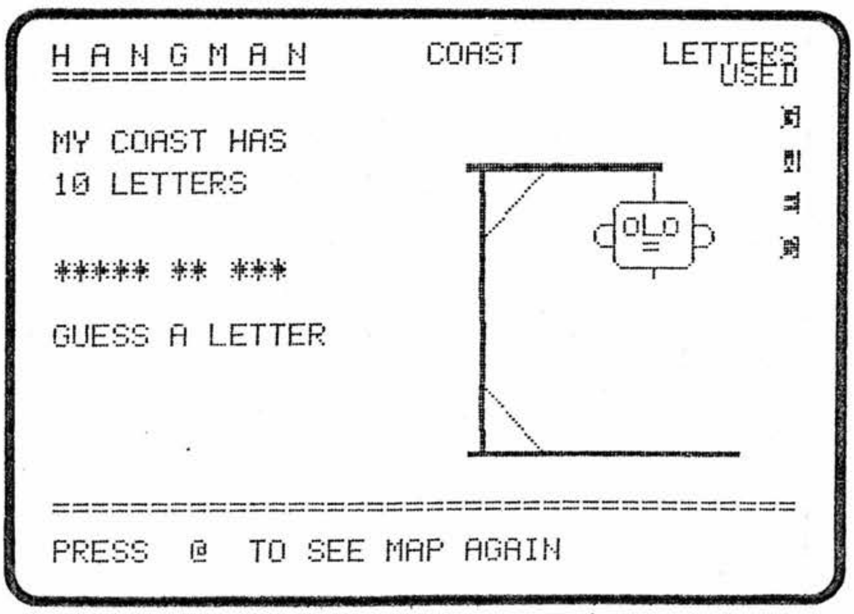
WHAT KIND OF PLACE DO YOU WANT?

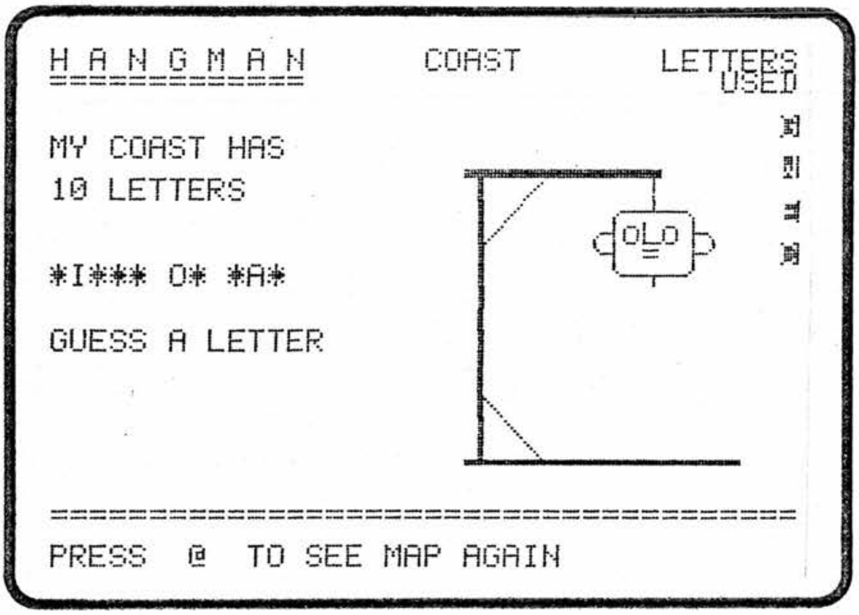
FOR :-

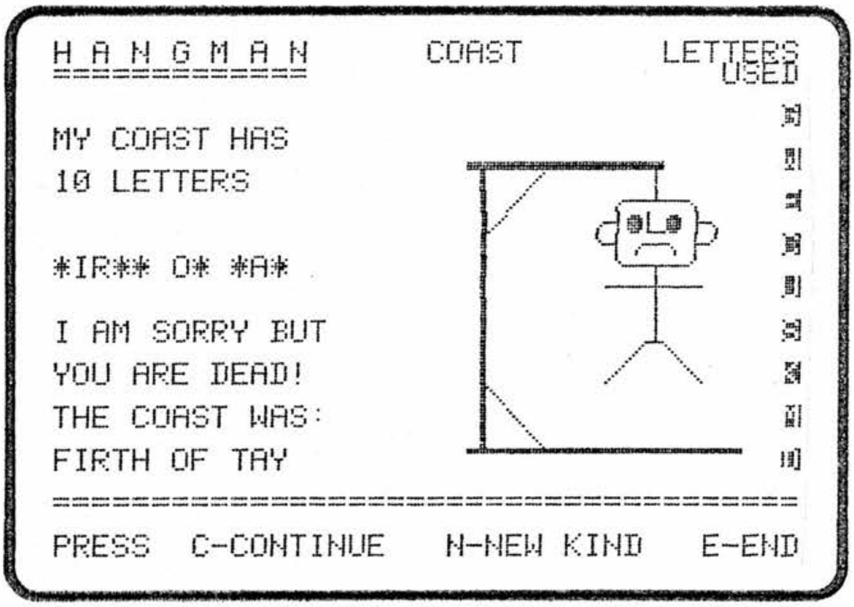
TOWN	TYPE T
COAST	TYPE C
GLEN	TYPE G
RIVER	TYPE R
LOCH	TYPE L
SURROUNDING	TYPE S

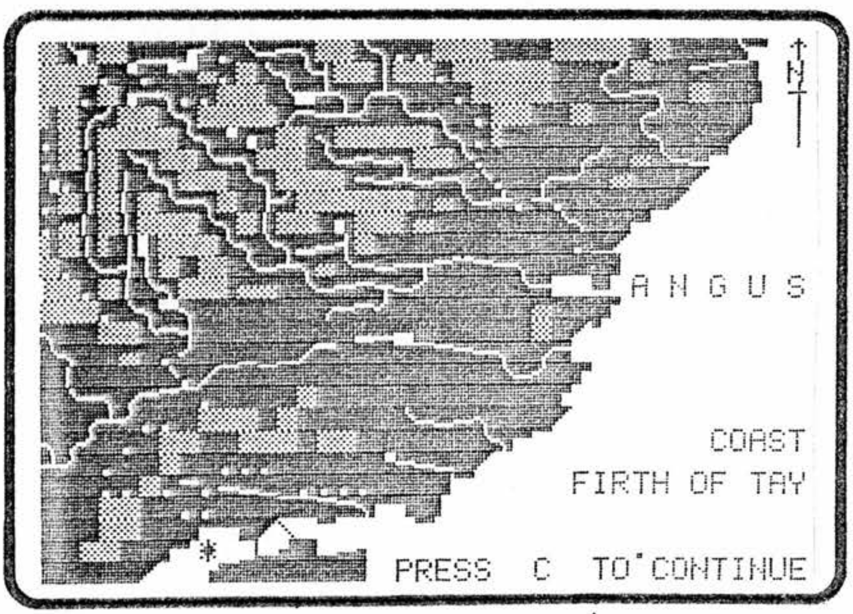

N
A N G U S
COAST
PRESS C TO CONTINUE

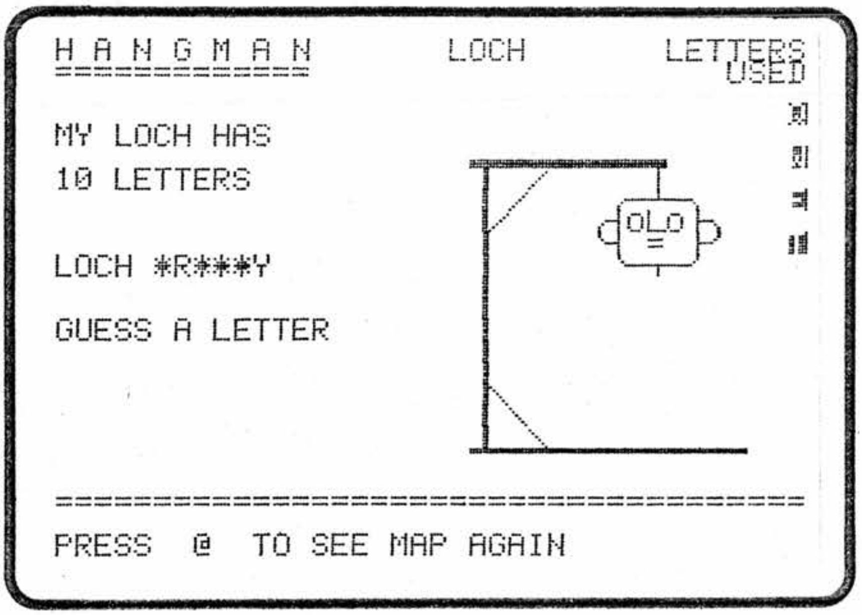

H A N G M A N
COAST
LETTERS USED
MY COAST HAS
10 LETTERS
***** ** ***
GUESS A LETTER
PRESS @ TO SEE MAP AGAIN

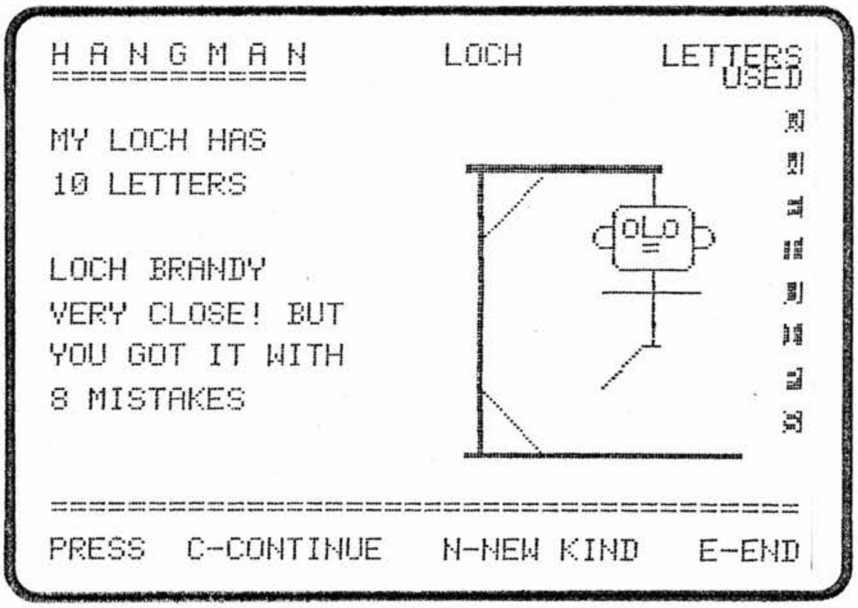

H A N G M A N
COAST
LETTERS USED
MY COAST HAS
10 LETTERS
***** ** ***
GUESS A LETTER
PRESS @ TO SEE MAP AGAIN

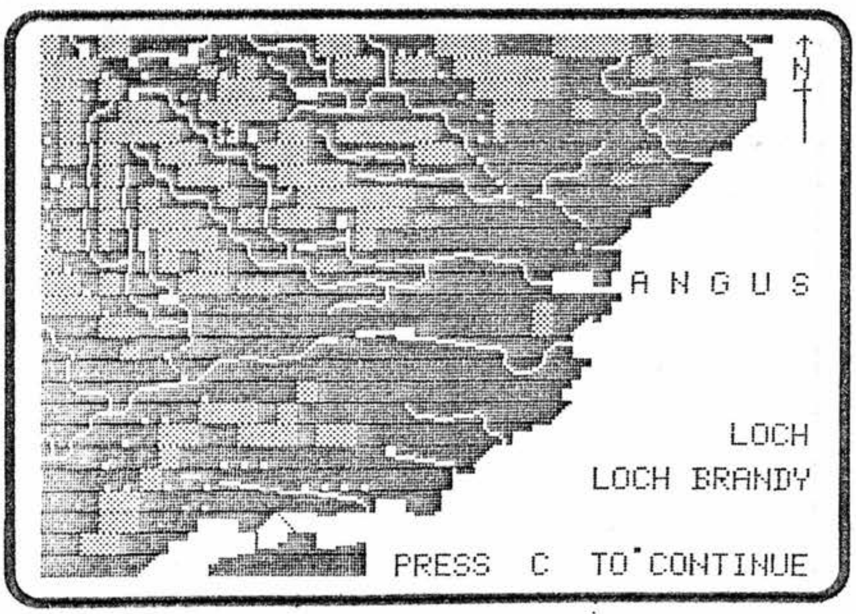

H A N G M A N
COAST
LETTERS USED
MY COAST HAS
10 LETTERS
*I*** O* *A*
GUESS A LETTER
PRESS @ TO SEE MAP AGAIN


H A N G M A N
COAST
LETTERS USED
MY COAST HAS
10 LETTERS
*IR** O* *A*
I AM SORRY BUT
YOU ARE DEAD!
THE COAST WAS:
FIRTH OF TAY
PRESS C-CONTINUE N-NEW KIND E-END


N
A N G U S
COAST
FIRTH OF TAY
PRESS C TO CONTINUE


H A N G M A N
LOCH
LETTERS USED
MY LOCH HAS
10 LETTERS
LOCH *R***Y
GUESS A LETTER
PRESS @ TO SEE MAP AGAIN


H A N G M A N
LOCH
LETTERS USED
MY LOCH HAS
10 LETTERS
LOCH BRANDY
VERY CLOSE! BUT
YOU GOT IT WITH
8 MISTAKES
PRESS C-CONTINUE N-NEW KIND E-END


N
A N G U S
LOCH
LOCH BRANDY
PRESS C TO CONTINUE

frequency analysis of letter use if random guesses appear to have been made. At any time the pupil can refer back to the map to check on the location of the required feature.

5.4.4 Biological Keys

Interest in environmental studies in the primary school is often curtailed by an absence of detailed knowledge on the part of the teacher. These programs encourage environmental studies and lead pupils to look carefully at biological features and make decisions on the basis of close observation of relevant details.

Minibeasts

This program helps the pupil identify any common land invertebrate animal. A series of pairs of statements are displayed and the pupil selects at each stage the statement that best describes the animal under investigation. Eventually the program gives the name of the animal, on the basis of the information supplied. The pupil must then check the identification in an appropriate reference book. If the identification is obviously incorrect a wrong decision has been made at some stage, and the program is rerun changing any dubious answers, until the identification is confirmed by the reference book.

Trees

All trees likely to be found in the locality of any school are identified by this key, based on the close observation of twigs and leaves.

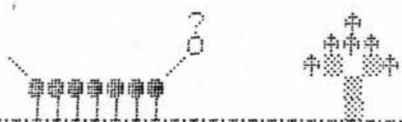
I D E N T I F Y   Y O U R

M I N I B E A S T

JACK F HADDOW

&

A RUSSEL WILLS



PRESS C TO CONTINUE

IDENTIFY YOUR MINIBEAST

THIS PROGRAM WILL HELP YOU TO IDENTIFY MOST OF THE COMMON LAND INVERTEBRATE ANIMALS.

SOME WILL BE IDENTIFIED BY NAME OTHERS WILL BE GIVEN ONLY THE NAME OF THE GROUP TO WHICH THEY BELONG.

PRESS C TO CONTINUE

IDENTIFY YOUR MINIBEAST

WHEN THE NAME IS GIVEN YOU SHOULD MATCH YOUR ANIMAL WITH A PICTURE IN A BOOK.

IF YOUR ANIMAL DOES NOT MATCH YOU HAVE MADE A WRONG DECISION IN THE PROGRAM.

TRY AGAIN AND CHANGE ANY DECISION WHICH WAS DOUBTFUL.

PRESS C TO CONTINUE

IDENTIFY YOUR MINIBEAST

A ⊕- MEANS THAT A MAGNIFYING GLASS WILL HELP YOU WITH YOUR DECISION.

LOOK AT THE ANIMAL AND PRESS 1 OR 2 FOR THE STATEMENT THAT BEST DESCRIBES THE ANIMAL.

PRESS C TO CONTINUE

IDENTIFY YOUR MINIBEAST

IF THE ANIMAL HAS LEGS

---- PRESS 1

IF THE ANIMAL HAS NO LEGS

---- PRESS 2 2

IDENTIFY YOUR MINIBEAST

BODY NOT LONG AND THIN OR WORM-LIKE

---- PRESS 1

NARROW WORM LIKE BODY

---- PRESS 2 1

IDENTIFY YOUR MINIBEAST

SHELL PRESENT

---- PRESS 1

NO SHELL PRESENT

---- PRESS 2 2

IDENTIFY YOUR MINIBEAST

THE ANIMAL IS

A SLUG

PRESS C TO CONTINUE

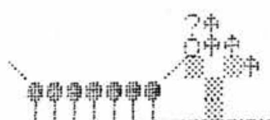
I D E N T I F Y Y O U R

M I N I B E A S T

JACK F HADDOW

&

A RUSSEL WILLS



PRESS C TO CONTINUE

IDENTIFY YOUR MINIBEAST

IF THE ANIMAL HAS LEGS

---- PRESS 1

IF THE ANIMAL HAS NO LEGS

---- PRESS 2 1

IDENTIFY YOUR MINIBEAST

6 LEGS PRESENT

---- PRESS 1

MORE THAN 6 LEGS PRESENT-BE CAREFUL-
DO NOT COUNT FEELERS

---- PRESS 2 2

IDENTIFY YOUR MINIBEAST

8 LEGS PRESENT

---- PRESS 1

MORE THAN 8 LEGS PRESENT

---- PRESS 2 2

IDENTIFY YOUR MINIBEAST

BODY OVAL WITH ABOUT 14 LEGS ●-

---- PRESS 1

BODY LONG WITH MORE THAN 14 LEGS ●-

---- PRESS 2 1

IDENTIFY YOUR MINIBEAST

THE ANIMAL IS

A WOODLOUSE

PRESS C TO CONTINUE

I D E N T I F Y Y O U R

M I N I B E A S T

JACK F HADDOW

&

A RUSSEL WILLS

PRESS C TO CONTINUE

5.4.5 Maths Puzzles and Logic Games

This category of programs are better suited to extend pupils, not relying on any previous knowledge, but on the ability to derive solutions to new problems while under certain constraints.

Polyominoes

Polyominoes are shapes created by joining a number of squares together so that each square is attached to another by at least one side. This program first explains what polyominoes are, then allows the user to specify how many component, squares he wants. The user then has to find all the different polyominoes that can be made using the specified number of squares. To define the polyominoes the user gives a series of ordered pairs of coordinates and the polyomino is built up on a grid on the screen. When all the squares have been specified the resulting shape is checked to see if it is a valid polyomino. If so a small replica is displayed at the bottom of the screen for future reference. If not valid a message is displayed and the grid is cleared. Valid polyominoes are rejected if they are rotations or reflections of those already found. When all the polyominoes are found a suitable congratulatory message is displayed.

This program helps pupils develop their spacial awareness and the concepts of shape reflection and rotation. The definition of the polyominoes gives practice in coordinates. Finding all of the polyominoes involves developing a logical strategy for the search.

Towers of Hanoi

This is the ancient game normally involving the transfer of different sized discs from one column to another. The series of ever decreasing diameter discs has to be moved from the initial column to another, making intermediate use of a third column. There are two rules: only one disc may be moved at a time, and at no time can a larger disc rest upon a smaller disc.

The program first explains these rules and allows the user to specify the number of discs in the initial column, then act as a polite, patient and infallible referee as the user tries to move the discs from one column to the other. When the user succeeds he is given a rewarding message, particularly so if he has done so in the minimum possible number of moves.

Towers of Hanoi requires planning and learning a strategy to achieve perfect scores. This is best achieved by starting with only a few discs, and increasing the number as the user technique and strategy develop.

P O L Y O M I N O E S
=====================

HOW MANY DIFFERENT
SHAPES CAN YOU FIND ?

RUSSEL WILLS

PRESS C TO CONTINUE

P O L Y O M I N O E S
=====================

POLYOMINOES ARE SHAPES MADE UP OF
A NUMBER OF SQUARES JOINED TOGETHER.

FOR EXAMPLE :-

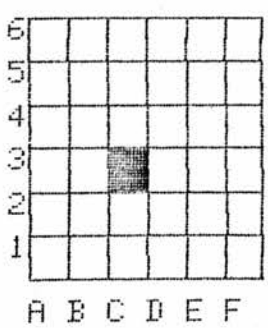
IS A VALID POLYOMINO
MADE OF 4 SQUARES.

IS NOT A VALID POLYOMINO
THE SQUARES DO NOT JOIN.

PRESS C TO CONTINUE

P O L Y O M I N O E S
=====================

TO BUILD A POLYOMINO YOU SPECIFY THE
SQUARES YOU WANT BY COORDINATES :-



C 3 IS THE FLASHING
SQUARE.

YOU MUST ENTER THE
LETTER FIRST THEN
THE NUMBER.

PRESS C TO CONTINUE

POLYOMINOES

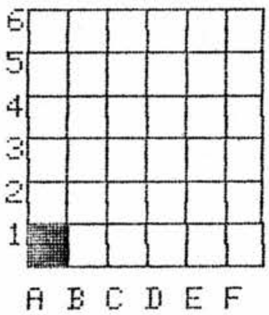
HOW MANY SQUARES DO YOU WANT IN
YOUR POLYOMINO ?
YOU CAN HAVE 3 , 4 OR 5 . 5

NOW TRY TO BUILD AS MANY DIFFERENT
POLYOMINOES AS YOU CAN.

ROTATIONS AND REFLECTIONS OF ONES
YOU ALREADY HAVE WILL NOT COUNT.

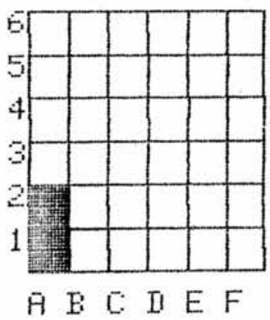
PRESS C TO CONTINUE

POLYOMINOES

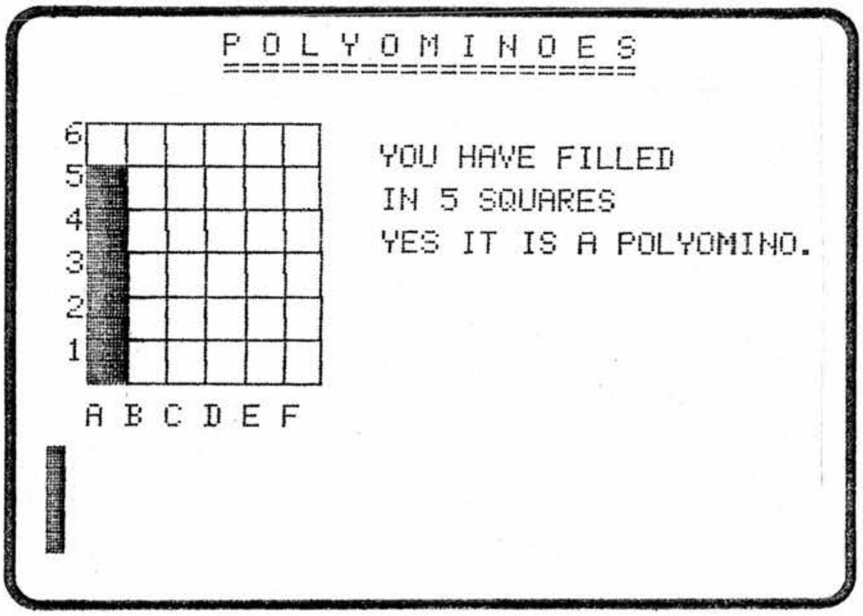


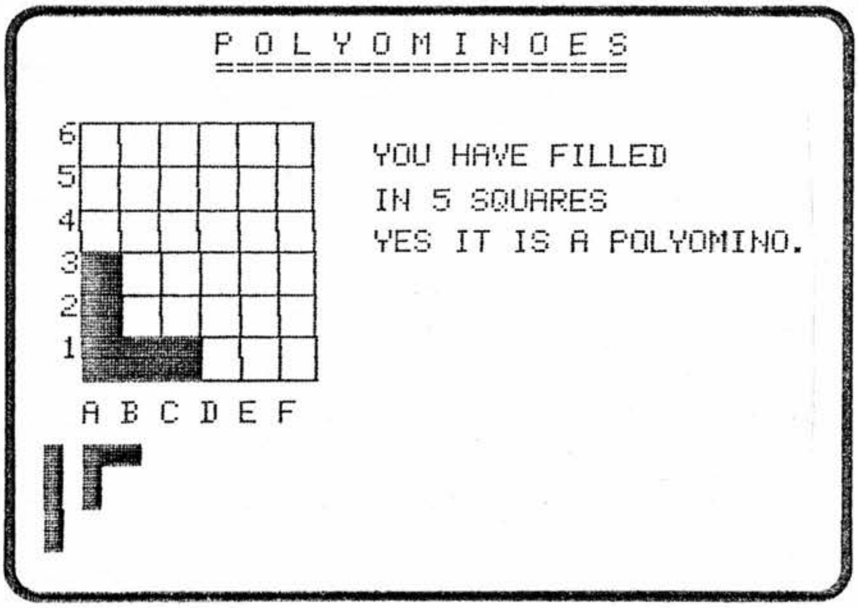
ENTER THE COORDINATES
OF A SQUARE OF YOUR
POLYOMINO A 1

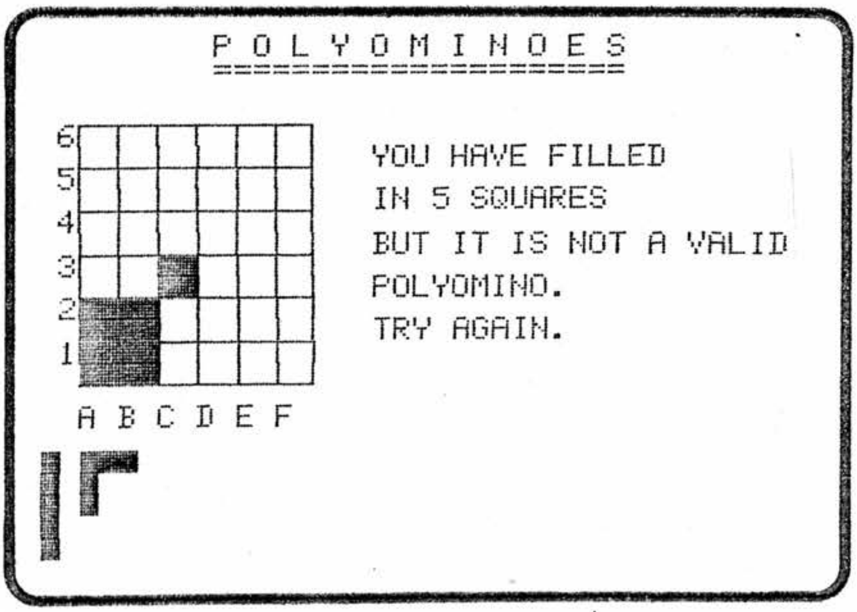
POLYOMINOES

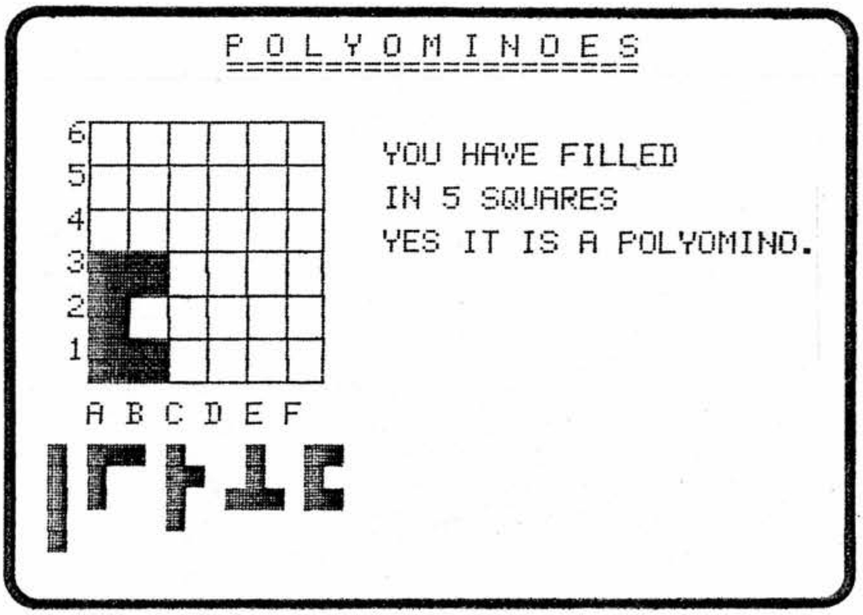


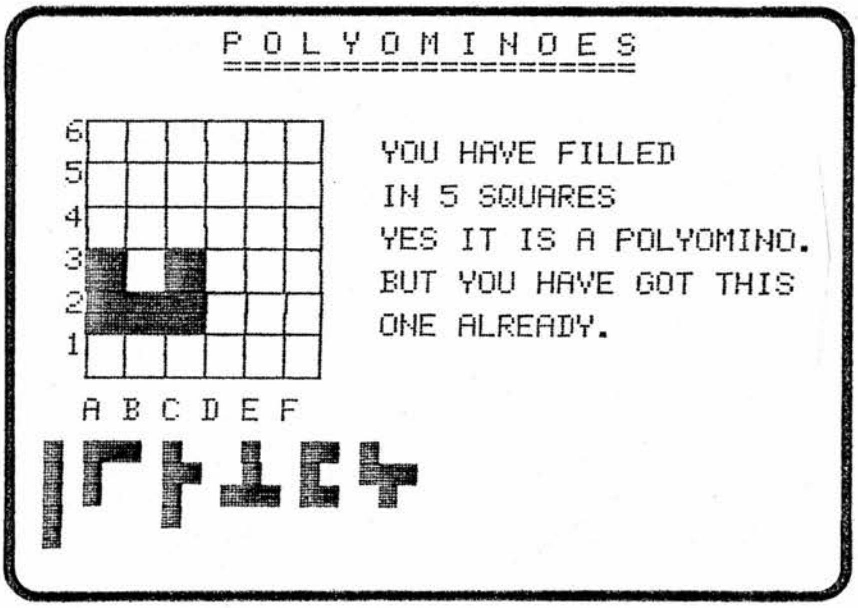
ENTER THE COORDINATES
OF A SQUARE OF YOUR
POLYOMINO A 2

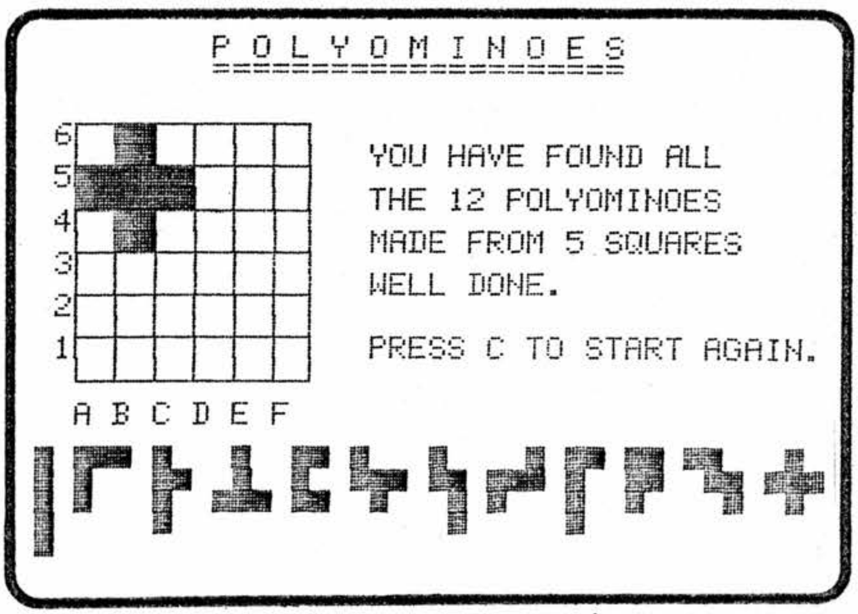

POLYOMINOES
6
5
4
3
2
1
A B C D E F
YOU HAVE FILLED
IN 5 SQUARES
YES IT IS A POLYOMINO.


POLYOMINOES
6
5
4
3
2
1
A B C D E F
YOU HAVE FILLED
IN 5 SQUARES
YES IT IS A POLYOMINO.


POLYOMINOES
6
5
4
3
2
1
A B C D E F
YOU HAVE FILLED
IN 5 SQUARES
BUT IT IS NOT A VALID
POLYOMINO.
TRY AGAIN.


P O L Y O M I N O E S
YOU HAVE FILLED
IN 5 SQUARES
YES IT IS A POLYOMINO.
6
5
4
3
2
1
A B C D E F


P O L Y O M I N O E S
YOU HAVE FILLED
IN 5 SQUARES
YES IT IS A POLYOMINO.
BUT YOU HAVE GOT THIS
ONE ALREADY.
6
5
4
3
2
1
A B C D E F


P O L Y O M I N O E S
YOU HAVE FOUND ALL
THE 12 POLYOMINOES
MADE FROM 5 SQUARES
WELL DONE.
PRESS C TO START AGAIN.
6
5
4
3
2
1
A B C D E F

6. EVALUATION

6.1 Introduction

Evaluating the success, or otherwise, of introducing a virtually unknown element of modern technology like a microcomputer into a primary school is a very difficulty task. This has been further complicated by the rapid, drastic and ongoing changes in the political awareness and educational attitudes to microcomputers in the classroom. This investigation started when very few primary schools had their own microcomputer, and most teachers had no idea what a microcomputer looked like, let alone any experience in using one. A microcomputer had therefore to be supplied before its introduction could be investigated. This created an artificial situation, where the school was anxious to make the greatest use of the computer during its limited loan, and rather different from that of a school acquiring its own computer permanently and hence creating a new stable situation. Being therefore the agent of the introduction and also actively involved in computer education the researcher was not a neutral observer. With time and equipment at a premium, uncooperative or disinterested schools were not actively persuaded to become involved in the investigation. This evaluation is essentially qualitative, and without carefully controlled parallel investigation into schools not having a microcomputer, it is an amalgam of personal observation of the few schools with their own computer and analysis of data from questionnaires completed by ten primary school teachers who were loaned PET microcomputers. (See Appendix 3)

The source of the microcomputer, whether borrowed or acquired, and if acquired whether purchased or given freely significantly affected the attitudes towards it and its use. A school that has had to save hard, and hold events to raise the finance for a computer has a significantly higher level of commitment to and expectation of results from their computer than one which has for whatever reason acquired one freely.

A similar situation exists with software, schools that were loaned a microcomputer were also loaned a range of software. Schools that had purchased their microcomputer expected to purchase the software, those given free machines were, in the main, looking for free software.

Software assessment poses further problems. The use of a narrow range of simple software is easily added to the daily timetable with a minimum of change to the rest of the day's activities, and with for example spelling, may bring noticeable and immediate improvement in pupil performance. More sophisticated software may require much longer preparation time from the teacher, and further teaching time to prepare the pupils and give them the necessary prerequisite knowledge to use the package. Any benefits accruing from the use of the package may be difficult to define and measure and may take some time to become apparent.

6.2 School Environment

The attitude of the staff, particularly the promoted staff, to innovation is the most crucial factor affecting the introduction of the microcomputer into a primary school. So far the acquisition of a microcomputer has usually been motivated by an enthusiastic individual, and with support from the head teacher no obstacle is too great, but if the desire for innovation is not present a thousand reasons for not getting a microcomputer can be found.

Even with a desire for educational innovation other factors may affect the situation. The physical situation of the school, its large size, old age, split sites, split levels, prefabricated huts and old fashioned electrical wiring systems, may initiate against successful innovation.

A small rural school with one or two teachers, only a few families and a falling school roll is likely to find the cost of a microcomputer, even with Department of Industry subsidy, beyond its means. It is to be hoped that local educational authorities will assist these schools since the smaller groups of pupils in rural schools make for smooth integration of computer assisted learning.

6.3 Staff Experience and Training

Previous experience of computers is obviously useful but enthusiasm and interest in innovation is far more important for successful introduction of microcomputers. Initial wariness is rapidly dispersed by use with pupils.

Training is essential. The Department of Industry recognise this by making a two day course for two staff a precondition of its subsidy. This however is merely a token. Progressively more sophisticated courses will be required as teachers involved with the computers reach levels of expertise to appreciate them. If computers are to be used by other than enthusiastic volunteers, some system of release for in-service training, either school based or at regional centres, will have to be instituted with considerable financial implications for the local education authorities.

6.4 Pupils

Without exception schools reported encouraging pupil reactions to the microcomputer: enthusiasm, enjoyment, excitement, high motivation and very receptive. For those pupils in small schools or classes and hence with a more than average exposure to the machine there was increasing discrimination between programs and a desire for further involvement with the development of new programs, and the desire to write their own programs.

No pupils avoided the microcomputer although some were hesitant at first, and preferred not to be the first to attempt a new program. The single teacher school tried to ensure that every pupil had a session with the microcomputer every day.

The mere introduction of a microcomputer into a class causes a novelty effect and while it was reported that this effect did wear off as pupils came to regard the computer as part of the classroom furniture, the interest and enthusiasm did not diminish until all the software supplied had been well tried out. That motivation of the pupils was increased by the micro was reported by most schools especially for the young, less able and remedial pupils who appear to benefit most.

The programs that prompted these comments were especially designed for the less able pupil, with positive responses and encouragement even when mistakes are made, to remove the fear of failure. Poor and untidy work does not attract teacher approval and as the less able pupils often have writing problems, pupil-teacher anatagonisms often arise. The computer has the added benefit of letting the pupil key in responses, avoiding the complication and diversion of writing, allowing him to work much faster and to see computer work as being much easier than in fact it is. Work on the microcomputer is not seen as work by the pupils but rather as play! Using the computer is encouragement in itself.

6.5 Curriculum

The current view of the curriculum in primary schools is too narrow and divided into the basic skills and the rest of the curriculum. The computer can assist with the basic skills but what is really needed is the teaching of basic skills in a meaningful context. Organising work in groups, group teaching is essential in a mixed ability class, provides an ideal opportunity for the use of the computer to encourage discussion of outcomes, thinking, understanding, deduction and justification. The computer can provide a realistic interactive learning situation which will motivate rather than the sterile passive text book or workcard situation.

Schools must plan their curriculum if it is to be active and meaningful, and integrate the use of the computer within that overall plan. Guidelines must be provided for teachers on the use of the computer to give the essential continuity within the curriculum.

Without exception the schools were anxious to use the microcomputer in all areas of the curriculum, providing appropriate, good quality, well documented software was available. Some teachers appreciated that this was rather ambitious with only one microcomputer per school and that they would therefore concentrate on enrichment and remedial work.

6.6 Management

The microcomputer does not bring order to a badly organised class, it merely adds to the disorder. In a well managed classroom the computer adds a new dimension to the curriculum. The management of the micro in a one or two teacher schools is relatively simple within the normal flexible situation in such schools. Problems arise in larger schools when several teachers want to use the only microcomputer in the school, then a school policy has to be formulated. Suggestions include cooperation, arbitration by head teacher, block bookings, timetable or acquisition of more microcomputers.

A further management problem is how to provide computer access for pupils in classes where the teacher, for whatever reason, is reluctant to use the computer. A team teaching situation can overcome this, where classes exchange teachers, so that a teacher with an interest in computers can take the class of one that is not interested. This can result in the computer enthusiast becoming overburdened with other classes. It is necessary for head teachers to prevent such situations and encourage all teachers to become involved. This will be simpler when there is a wider range of suitable software to appeal to all teachers.

6.7 Software

Most teachers see themselves carefully directing the pupils to the appropriate software that links in with the other work planned. The most useful software, from the teachers viewpoint, is that which fits most comfortably and closely into the current pupils' projects, enriching and reinforcing work already being done. This is particularly so if it can be adjusted to the individual or group requirements. Programs that can be readily adapted or amended to better suit individual needs are particularly favoured.

The pupils especially enjoyed those programs with a competitive element, when they tried to beat the computer, and those with interesting visual effects or any program they had not previously seen. Using the computer is so attractive to the pupils that it is occasionally used by the teachers as a carrot to encourage completion of other more mundane tasks, conversely, deprivation of computer time is seen as a disciplinary tool.

Teachers wanted development of software in all areas, but especially in environmental studies, language arts and in programs developing thinking, strategy, decision making, communicating and problem solving skills. These latter skill testing situations are generally difficult to set up in realistic and meaningful ways in the classroom without a microcomputer. The areas in which the teachers want development are perhaps the areas in which they feel they are not strong and the computer is well fitted to help them.

6.8 Support

To maximise the benefit of the computer in the school the teachers feel the need for a range of supporting services. Parents are in general very interested and enthusiastic for their children to be involved with computers and are prepared to finance this within their own limits. Some parent-teacher associations are anxious to push their reluctant schools to get a computer and will even provide all the necessary finance while other head teachers feel it is the responsibility of the local authority to cover the whole cost of the microcomputer.

Acquisition of the hardware is only the beginning. Regional support is required for maintaining, repairing and enhancing the hardware. Software is rapidly becoming a national concern and its quality and quantity should rapidly improve. Local software development groups will be essential if teachers are to be able to influence the programmers to produce the kinds of software they require. While each school will need to develop its own so called expert, regions will have to make access available to more experienced expert consultants to assist in solving more difficult software problems.

7. CONCLUSIONS

Microcomputers will be introduced into primary schools. The political will now exists to make this happen and by the end of 1986 there will be few, if any, primary schools without at least one microcomputer. It is perhaps unfortunate that the government has seen fit to introduce microcomputers into schools through the Department of Industry as a support to British computer manufacturers rather than through the Department of Education and Science, or the Scottish Education Department for the maximum benefit for education. This has put too high an importance on hardware, to the virtual neglect of the educational software, but has forced a virtual standardisation of the hardware to BBC Model B over large parts of the UK with enclaves of Research Machines 480Z where authorities are prepared to pay above the average to support computers, and Sinclair Spectrum where authorities wish to pay less.

When the hardware arrives in the schools the teachers will rapidly become aware of the potential of the microcomputer but will be impatient to see the actual benefits, and that will be the beginning of huge new demands from teachers for more suitable and effective software for their pupils, and more in-service training for themselves to make the fullest use of the new technology. One microcomputer in an average primary school will soon be recognised as totally inadequate and money and human resources will have to be made available for more hardware, and more appropriate hardware, like concept keyboards for infants and the physically handicapped, larger monitors for class work and printers for hard copy, but even more important for more and better software.

Very little software of any kind was available for primary schools at the start of this investigation, in 1979, so the researcher was obliged to write his own. The situation has changed somewhat but the majority of the software now available is still of the relatively simple drill and practice type, which though not totally educationally desirable does provide a familiar and comfortable introduction for the teacher who is new to and wary of microcomputers. Once familiar with the microcomputer and the simple introductory software the competent and experienced teacher will be looking for more sophisticated and demanding software exploiting the advantages of the computer to the full. This kind of software takes considerable time and resources to prepare and further time to fully evolve, so is unlikely to be ready when the teachers require it.

With standardisation of the hardware, software provision becomes a national rather than local problem. SMDP has recognised this and is now developing a software library and information service, including support for in-service training.

The Colleges of Education are anxious to assist with the in-service training but with reducing staffs, due to falling school rolls and the reduction in demand for teachers, they have insufficient experienced staff to cope with the demand. The demand will be huge and increasing: first for familiarity courses on how to use the hardware and software as they exist at present; then on software amendment to better fit the programs to their own class; but most of all for classroom management and how to make best use of the microcomputer in the classroom. The more sophisticated programs and packages on simulation, decision making, information retrieval and other languages like LOGO and PILOT would each need a separate course to prepare teachers to use them properly. The use of LOGO for the pupils is highly desirable but hugely demanding on computer facilities if more than a few pupils are to enjoy the benefits.

What is required now is a major effort from SED, SMDP, Colleges of Education, local Education Authorities and the schools themselves to encourage the teachers to treat the microcomputer as an integral extra dimension of the whole evolving curriculum and not an expensive irrelevance. The BBC hardware is coming, even though with its many connecting wires and power cables it is not ideal. The software likewise is beginning to come although it will never be considered sufficient, well enough documented or of high enough quality. The courses will come as they are demanded, and sufficient staff are prepared to give them. Support for hardware, for software development, expert technical advice and curriculum content must be made available.

This investigation has been made at the very beginning of what will rapidly become a huge involvement of microcomputers in primary schools. It will be interesting to observe the increasing tempo of development as more schools get their own microcomputers and teachers move from hesitant novices to experienced hardware users and from an indiscriminate naive acceptance to a critical appraisal of software. How far teachers will wish to go along the sophisticated software path, when they see the full implications, would be a fascinating study.

One thing is certain, the pupils will enthusiastically follow the progress of the microcomputer in the classroom, rapidly familiarising themselves with all new developments and leaving their teachers far behind when it comes to imaginative use and destructive abuse of the software.

Under the Department of Industry scheme the acceptance and integration of microcomputers into the primary school will be accelerated. However, it will be some years before the microcomputer's impact and use in these schools can be fully assessed.

To have been so involved at the start of such an interesting innovation has been a most fascinating privilege.

8. BIBLIOGRAPHY

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HMI of Schools: The Education of Pupils with Learning Difficulties; Edinburgh, HMSO, 1978

HMI of Schools: Learning and Teaching in Primary 4 and Primary 7; Edinburgh, HMSO, 1980

Ellingham, D: Managing the Microcomputer in the Classroom; London, CET, 1980

Jones, R: Microcomputers in the Primary School: A Before-You-Buy Guide; London, CET, 1980

Jones, R: Five of the Best: Computer Programs in Primary Schools; London, CET, 1980

Papert, S: Mindstorms Children, Computers and Powerful Ideas; Brighton, Harvester Press, 1980.

West, R: Programming the PET/CBM; London, Level Limited, 1981

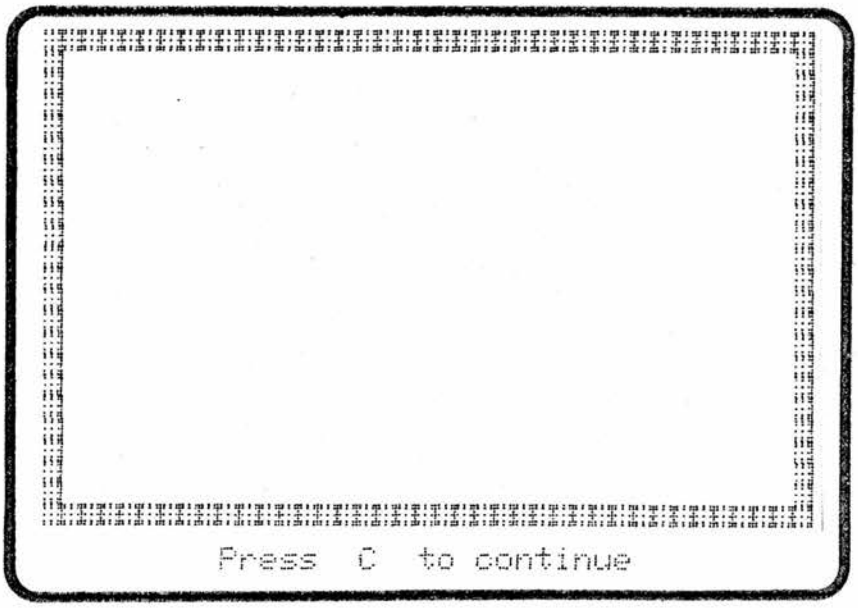
9. APPENDIX 1

Subroutines and Routines

(a) Title Surround.

```
1000 REM ** TITLE SURROUND **
1010 :
1020 C$="▒#":PRINT"]";:FORI=1TO39:PRINTC$;:NEXTI
1030 FORI=1TO22:PRINT"■■"C$;:NEXTI:PRINT"■";
1035 FORI=1TO38:PRINT"■"C$"■";:NEXTI
1040 PRINTC$:FORI=1TO23:PRINT"]"C$"■";:NEXTI
1045 PRINT"■":RETURN
1050 :
1060 :
2000 REM ** PLEASE TURN OVER **
2010 :
2020 PRINT"■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■";
2025 PRINT"RESS  -  TO CONTINUE";
2030 GETC$:IFC$<>"-"ANDC$<>"C"THEN2030
2040 RETURN
```

```
GOSUB 1000 : GOSUB 2000
```



(b) Do you have printer?

```
1200 REM ** PRINTER AVAILABILITY **
1205 :
1210 IFPR=1THEN1290
1220 PRINT"▒▒▔D YOU HAVE ▒PRINTER▒ ATTACHED, PLUGGED IN
1230 PRINT"AND SWITCHED ON? (▔RESS  ├YES ╱─NO) ";
1240 GETC$:IFC$="N"THENPR=0:PRINT"╱":GOTO1290
1250 IFC$="Y"THENPR=1:PRINT" ├":OPEN1,4:GOTO1270
1260 GOTO1240
1270 PRINT"▒▏YPE THE ▒DATE▒ THEN PRESS ▁▔▏╱─╱ KEY.":PRINT
1280 CMD7,;:INPUTD$:PRINT#7:IFLEN(D$)<1THEN1270
1290 GOSUB2000
```

```
Do you have printer attached, plugged in
and switched on? (Press Y-yes N-no) N


        Press  C  to continue
```

```
Do you have printer attached, plugged in
and switched on? (Press Y-yes N-no) Y
Type the date then press RETURN key.
12 March 1983


        Press  C  to continue
```

(c) Pupil Handshake

```
 1300 PRINT"□UPIL'S ⁄OTES"
 1310 PRINT"======= ====="
 1320 PRINT"▒▒LEASE TYPE YOUR ▒NAME▒ ON MY KEYBOARD
 1330 PRINT"▒THEN PRESS THE ─┐ ⁄─⁄ KEY.":PRINT
 1340 CMD7,;:INPUTN$:PRINT#7:IFLEN(N$)=0THEN1320
 1350 IFLEN(N$)>20THENN$=LEFT$(N$,20)
 1360 PN=PN+1:A$(PN)=N$:PRINT"▒▒ELLO "N$","
 1370 PRINT"▒ AM GOING TO GIVE YOU SOME BOXES"
 1380 PRINT"▒TO FILL IN."
 1390 PRINT"▒▒OOD LUCK.":GOSUB2000
READY.
```

```
Pupil's Notes
======= =====

Please type your name on my keyboard
then press the RETURN key.
Martyn

Hello Martyn,
I am going to give you some boxes
to fill in.

Good luck.


            Press  C  to continue
```

(d) Results

```
236 IFPR=0THEN246
238 PRINT#1,CHR$(1)"  ¯ ♥ / L | ♥       "CHR$(129)
240 PRINT#1:PRINT#1,"-OUNTING"SPC(26-LEN(STR$(MX)));
241 PRINT#1,"\AX /UMBER ="MX:PRINT#1
242 PRINT#1,"|IME ="T"SECS."SPC(27-LEN(D$)-LEN(STR$(T)));
243 PRINT#1,"¬ATE : "D$:PRINT#1
244 PRINT#1,"/UMBER  /AME"SPC(22)"_IGHT  ORONG":PRINT#1
246 PRINT"_ ¯ ♥ / L | ♥   -OUNTING   \AX NUM="MX
248 PRINT"/UM  /AME (|IME="T"SECS.)"TAB(29)"_IGHT ORONG"
250 FORI=1TOPN
252 PRINTITAB(5)A$(I)TAB(28)G(I)TAB(34)B(I):IFPR=0THEN258
254 PRINT#1,SPC(6-LEN(STR$(I)))I" "A$(I)SPC(25-LEN(A$(I)));
256 PRINT#1,SPC(6-LEN(STR$(G(I))))G(I)SPC(6-LEN(STR$(B(I))))B(I)
258 NEXTI:PRINT:PRINT:IFPR=1THENPRINT#1:PRINT#1
260 PRINT"";
261 PRINT"¬RESS ¬ FOR NEXT PUPIL,  _ FOR RESULTS,
262 PRINT"     ♥ TO START AGAIN   OR   ¯ TO END.";
264 GETC$:IFC$=""THEN264
266 IFC$="P"THEN98
268 IFC$="R"THEN236
270 IFC$="S"THEN20
272 IFC$="E"THEN298
274 GOTO264
```

R E S U L T S

Counting		Max Number = 10	
Time = 15 secs.		Date : 12 March 1983	
Number	Name	Right	Wrong
1	Martyn	3	0
2	Jonathan	4	0
3	Miriam	4	0
4	Peter	4	1

```
R E S U L T S   Counting   Max num= 10

Num  Name (Time= 15 secs.)   Right Wrong

 1   Martyn                    3     0
 2   Jonathan                  4     0
 3   Miriam                    4     0
 4   Peter                     4     1



Press P for next pupil,  R for results,

      S to start again   or   E to end.
```

APPENDIX 2

Commercial Educational Software Sources

Acornsoft, Fulbourn Road, Cherry Hinton, Cambridge

Addison-Wesley Publishers Limited,

53 Bedford Square, London, WC1B 3DZ

BBC Software, 35 Marylebone High Street, London, W1M 4AA

Cambridge Micro Software,

The Edinburgh Building, Shaftesbury Road, Cambridge, CB2 2RU

Cambridge Software House,

Town Hall, St Ives, Huntington, Cambridge

ESM, Duke Street, Wisbech, Cambridgeshire

Five Ways Software,

Maxim House, 692 Bristol Road South, Northfield, Birmingham

Ladybird Longman Microsoftware,

Longman House, Burn Mill, Harlow, Essex, CM20 2JE

Ginn Microcomputer Software,

Prebendal House, Parson's Fee, Aylesbury, Bucks, HP20 2QE

Heinemann Computers in Education,

22 Bedford Square, London, WC1

APPENDIX 3

Summary of Questionnaire Responses

Ten schools were loaned a PET microcomputer, and a range of software including the programs from this project. The following is a summary of responses to a questionnaire (see Appendix 4) completed after the loan period.

School features

The number of teachers and pupils varied from a single teacher with 16 pupils in an isolated glen school to 17 teachers and 380 pupils in a large urban school.

The newer open plan schools with space due to falling pupil numbers, all classrooms on a single level and ample power points considered themselves best able to introduce computers. Small schools with few pupils or one room with everyone and everything in it recognised that the computer would rapidly be integrated in the already flexible situation.

Very small schools feared financial burden on only a few families. Older schools complained of too few and outdated power points, split sites, stairs and small rooms making computer mobility difficult. The absence of secure storage to prevent theft and vandalism worried many teachers.

Teacher considerations

Only one teacher had more computer experience than a single in-service course. All teachers considered training to use the computer essential, the majority also wanted to be able to alter programs to suit their own requirements. Longer training courses for enthusiastic and interested teachers were suggested to provide the expertise required in the school to help support nervous teachers and run self-help workshops but primary teachers already consider themselves heavily burdened, without taking on extra work. Other teachers looked for outside support to write programs and set up software resource centres.

Pupils

Pupils attitudes were positive and enthusiastic at all schools. Small schools had some problems with pupils monopolising the computer. A few pupils were hesitant at first, but no pupils avoided the computer completely. The novelty effect soon wore off and the pupils treated the computer as part of their normal routine, looking for more and different software as they became more expert at handling the computer and software. Teachers generally noted an increase in the concentration span using the micro, particularly with remedial and less able pupils. Pupils considered using the computer as play, rather than work, and teachers saw an improvement in speed, accuracy, willingness to work and confidence especially in pupils with writing difficulties.

Finance

All schools, except those with only one or two teachers, could afford to pay the other half of the cost of the Department of Industry subsidised computers. Parents of pupils at all the schools were supportive and anxious that their children become involved with computers, while not always understanding the full implications of computers in school.

Curriculum

Teachers wanted the computer to be used in all areas of the curriculum, and generally appreciated the need for appropriate, good quality software, particularly in difficult areas like enrichment, remediation, phonics, art and music. One teacher wanted programs for administration too.

Management

The unanimous opinion was that all teachers and pupils should use the microcomputer. The assignment of priority was a more contentious issue with several suggestions that remedial pupils get priority and others that the older pupils needed more time. Timetabling or block allocation and more microcomputers were seen as ways to resolve conflicts of interest within the school. The teachers wanted to carefully control the programs the pupils used in order to link in with their teaching programme, and not give free pupil choice of program except on special occasions.

Software evaluation

The most useful program, from the limited range available, was almost invariably the program that fitted most closely into the teacher's current teaching plan, or project work. This emphasised the teachers' perceived need for as wide a range of software as possible.

The pupils' preference was for competitive scoring programs and visual programs with an insatiable curiosity for anything new. The most popular areas for new program development were environmental studies and language skills with a request to move away from basics and into simulations and strategy development.

Other comments

The overall impression from teachers comments is one of optimism that computers will be successfully integrated into primary school despite an awareness of the many difficulties. Some teachers were worried about the technical problems of keyboard, monitor, connecting cables and power plugs although actual exposure to computers had dispersed much of the initial worries. Time was limited for these trials and a few teachers wanted a longer trial period to properly evaluate long term pupil benefits. The changes required in classroom organisation, the shortage of good software, the need for good record keeping, how to motivate disinterested staff and the provision of satisfactory in-service courses were some of the factors that worried many teachers.

The keen interest of the majority of staff, the enthusiasm of all the pupils, and the appreciation of the microcomputer as a valuable classroom aid in both basic training and the provision of new, improved and otherwise unobtainable learning situations justified the overriding optimism that microcomputers in primary schools will be a success.

Appendix 4

MICROCOMPUTERS IN THE PRIMARY SCHOOL

Questionnaire

This questionnaire is part of a research project investigating the role of the microcomputer in the primary school. Your time, effort and cooperation in answering the questions as fully as possible would be much appreciated. Your remarks and comments will be treated in strictest confidence.

Please return to:

A R Wills
Lecturer in Computer Education
Dundee College of Education
Gardyne Road
Broughty Ferry
DUNDEE DD5 1NY

NAME ....

POSITION .... DATE ....

A. SCHOOL ....

NUMBER OF TEACHERS ....

NUMBER OF PUPILS ....

Particular features of school or buildings you feel might affect the introduction or use of microcomputers.

Advantages:

Disadvantages:

Other:

B. Teachers

Do any of the teachers have previous experience of using computers or microcomputers?

In-service training is expensive, time consuming and in the immediate future is unlikely to be as readily available as is required. Bearing this in mind, what training do you consider is necessary for the teachers?

Training to use computer and programs?

Training to change programs?

Training to write programs?

Training to design and develop educational programs for some other agency to program onto the computer?

Training for one or two "selected" teachers?

If so, how should they be selected and used within the school to help others gain experience?

Other:

C. Pupils

Pupils in general are always interested in novel equipment, and their background to computers is normally through "arcade type" video-computer games and home computers.

What is the general pupil attitude to computer programs?

Do some pupils tend to monopolise the machine despite your efforts to ensure fair share?

How can this be avoided?

Do some pupils avoid the computer?

If so is this because of lack of confidence in

1. own academic ability
2. use of the computer?

Does the novelty effect wear off?

Is there any change in effective concentration span using the micro?

Have you any proof of this?

Is there any improvement in skills?

Have you any proof?

Is there any change of attitude to "work" on the microcomputer?

Is the motivation of normally "unwilling workers" significantly improved?

Other:

D. Finance

The cost of microcomputers is considerable and it is unlikely they will be supplied by the local educational authorities. The Department of Industry is offering to pay half the cost of one micro if it is of an approved type.

Can the School afford the other half of the Department of Industry offer?

Are parents interested in supporting computing in the school?

E. Curriculum

Assuming that your school gets a microcomputer:

In what areas of the curriculum would you like to see the microcomputer used?

Maths and Language - Reinforcement of basic skills and concepts.

Maths and Language - Extension of skills and concepts for more able pupils

Environmental Studies and Project Work

Enrichment

Remedial

Computer studies and programming

Other: Please specify.

F. Management

Assuming that you acquire a range of different software for the majority of your pupils:

Who should use the microcomputer?

How should conflict of interests be resolved?

Should every teacher use the micro?

Should every pupil use the micro?

Should pupils be allowed a choice of program?

Other comments:

G. Software Evaluation

You have probably only seen and used a limited number of educational microcomputer programs. Of those programs which program was most useful? Why?

Which program did the pupils most enjoy? Why?

What area would you wish new program development to concentrate upon?

H. Other Comments

You have been asked a number of questions on various topics concerning microcomputers in primary schools. Please give below any further comments, observations or criticisms that you wish to make on any aspect of computing in the primary school.

Thank you for your cooperation.