Strategies for the introduction of computer awareness and computer literacy

HSRC Education Research Programme

Strategies for the introduction of computer awareness and computer literacy

Report of the Work Committee: The computer in education and training Part 5

Pretoria
Human Sciences Research Council
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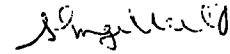
PREFACE

The Work Committee: The computer in education and training is one of a number of work committees appointed in terms of the HSRC Education Research Programme with a view to conducting continued research into education, particularly in the light of the findings and recommendations contained in the HSRC Education Report: Provision of Education in the RSA.

The specific task of this work committee was to conduct an investigation into the possible use of the computer in education and training. With a view to carrying out the assignment a number of research themes were identified and project committees appointed to undertake the research. This research effort resulted in nine subreports that were subsequently integrated in a work committee report. A number of individual reports however, are of such relevance that it has been decided to release them as separate publications. The full set of reports on the computer in education and training constitutes the following:

Part 1: The computer in education and training: findings and recommendations
Part 2: The computer in education and training: supporting reports (limited edition)
Part 3: Specifications for microcomputer systems in schools and other educational institutions: guidelines for users
Part 4: Specifications and criteria for the design and evaluation of educational courseware: guidelines for users
Part 5: Strategies for the introduction of computer awareness and computer literacy

This report (part 5) deals with the strategies for making pupils and teachers as well as the broad public aware of computers and for making them computer literate. It is trusted that this report will create a greater understanding of what these matters involve and will also promote an awareness of the potential and uses of the computer. Full particulars on the team responsible for the research that preceded this report, are given elsewhere. Our sincere thanks to everyone who contributed to the research and the writing of the report.



S.W.H. ENGELBRECHT
CHAIRMAN OF THE WORK COMMITTEE: THE COMPUTER IN EDUCATION AND TRAINING
HSRC EDUCATION RESEARCH PROGRAMME

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1. THE COMMITTEE

The members of the Research Committee were the following:

Dr S.W. Walters (Chairman)	:	Cape Education Department
Mr M.J. Chiles	:	South African College High School
Prof. W.T. Claassen	:	University of Stellenbosch
Mr D.S. Gear	:	St. Stithian's College
Dr J.D. Roode	:	Computer Users' Council
Prof. A.J.L. Sinclair	:	University of Western Cape
Prof. P.E. Spargo	:	University of Cape Town
Prof. S.H. von Solms	:	Rand Afrikaans University

2. SUBCOMMITTEES

The project was subdivided into seven subprojects, as follows:

2.1 Definition of Computer Awareness (CA) and Computer Literacy (CL)	:	Full Committee
2.2 Information and literature search and bibliography	:	Mr D.S. Gear (Convener)

2.3	Identification of persons and organizations which could be involved in the implementation of CA and CL Programmes	:	Dr S.W. Walters (Convener) Dr J.D. Roode Prof. P.E. Spargo
2.4	Design of Strategies and methods for the introduction of CA and CL programmes	:	Prof. P.E. Spargo (Convener) and University of Cape Town design team.
2.5	The design of outline programmes for CA and CL	:	Mr M.J. Chiles (Convener) Mr D.S. Gear Dr S.W. Walters
2.6	The determination of priorities for the implementation of the recommendations	:	Full Committee
2.7	The identification of the administrative procedures required for the implementation of the recommendations	:	Full Committee

3. EDITORIAL SUBCOMMITTEE

The Committee appointed the following members to write and edit the final report:

Dr S.W. Walters (Convener)
Mr M.J. Chiles
Prof. A.J.L. Sinclair

4. PARTICIPANTS IN THE SUBPROJECTS

In addition to the committee members the following persons contributed to the work carried out by the various sub-committees.

4.1 Strategies for the introduction of CA and CL programmes:

Prof. P.E. Spargo (Convener), University of Cape Town

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STRATEGIES FOR THE INTRODUCTION OF COMPUTER AWARENESS AND COMPUTER LITERACY

1. INTRODUCTION

1.1 AREAS IN EDUCATION WHERE COMPUTERS ARE CURRENTLY BEING USED

1.1.1 The teaching of Computer Studies/Computer Study/ Computer Science

In the RSA the terms Computer Study and Computer Studies are used at high school level, while at tertiary level Computer Science is generally used. In addition courses in related fields, such as Programming, Data Processing, Data Structures, Accounting Systems and Information Systems are offered at universities and technikons.

1.1.2 Computer Awareness and Computer Literacy Programmes

At present these are limited to local and small-scale efforts of individual schools and teacher-training institutions, and to teaching personnel, teachers-in-training and pupils. No evidence was found of Computer Awareness and Computer Literacy Programmes outside these areas.

1.1.3 Computer-Based Education, comprising computer-aided learning (CAL), computer-aided instruction (CAI), computer managed learning (CML) and computer managed instruction (CMI). The utilization of computer-based education in schools is limited in scope and distribution, and the application in the tertiary sector varies considerably, ranging from the extensive use of the Plato system at the University of the Western Cape to limited use in single university departments.

1.1.4 Information retrieval and dissemination

Work is being done in this field at present, e.g. careers library, test item bank, etc.

1.1.5 Educational software development

Most software is still being imported although some local development is taking place in certain subject areas and at certain institutions. No evidence of the development of software for computer awareness and computer literacy could be found, and a national co-ordinating mechanism or body does not exist.

1.1.6 Schools administration

Commercially developed systems are available. No official departmental system is as yet available.

1.1.7 Extramural activities, e.g. Computer Clubs, Computer Chess Clubs, etc. These are offered by individual schools and currently form the main contribution towards computer literacy and computer awareness.

1.2 THE NEED FOR COMPUTER AWARENESS AND COMPUTER LITERACY

1.2.1 The computer has already become part and parcel of man's everday existence. Without doubt the present and future generations will increasingly become dependent upon, and be involved with, the use and application of computers in an ever-increasing number of fields.

The development of the art of writing and of printing has led to an education system in which the ability to read and write, i.e. literacy, is universally accepted as a matter of course as an essential prerequisite basic skill. This has come about because information is stored in books and documents, or on

film, in the form of the printed word, and is retrieved by reading. Literacy is therefore essential for the proper utilisation of any book-based information storage and retrieval system.

With the advent and development of the computer, and the availability of relatively inexpensive personal computers, more and more information is being stored in computer-linked memory systems and processed by computer techniques. In this regard the development of programming languages for specialised tasks has so rapidly led to an extension of the uses and abilities of the computer in a variety of fields, that there is, in effect, no area - including education - in which computer-based information storage, retrieval and processing systems are not employed.

These developments have generated the needs for a new kind of literacy - namely computer literacy. Instruction in reading and writing skills, book education and library education, has its parallel in instruction in computer awareness and computer literacy. In addition to the teaching of the literacy aspect, the effects of technophobia (especially among adults) and the mysteries and misconceptions which have developed around the computer, have to be removed and counteracted.

1.2.2 In trying to determine priorities in the educational application of computers, the following aspects are immediately apparent:

* Computer Studies, Computer Science, and their related specialised subject areas, are reserved for the fairly limited number of individuals specially concerned with furthering their interest and careers in the computer field.

It is not foreseen that these subjects will develop into more than electives.

* Computer-based Education is a rapidly developing field, depending, inter alia, on the development of suitable software and economical and easy to use network systems suitable for a group-user mode in which each learner can proceed individually at his or her own pace. At present this mode is available on main-frame systems and microcomputer systems in the more expensive price range only. The main limiting factor, however, is the lack of suitable educational software of high quality specially designed for South African conditions and curricula.

* Information retrieval and dissemination applications in education are being developed. Their widespread use will depend on the effectiveness of a national communications network and the availability of user terminals.

* Educational software development. Experience has shown that the best educational software is developed by practising teachers. Both the quantity and the quality of the course and lesson ware are dependent upon the number of teachers with adequate knowledge of computers, computer-based instructional methods and programming. The development of "plain language" programming techniques and simple authoring languages may eventually supersede the need for programming expertise, but a fairly high level of computer literacy will always be a prerequisite.

* Administrative use of the computer is one of the main reasons advanced by schools for the purchase of computers. Software is at present supplied by commercial organizations which usually also provide the training required to run their particular systems and programs. No special national effort in training actual and potential users is deemed necessary at this stage.

* Computer awareness and computer literacy are obviously part of the preparation of the users of all the different modes mentioned above, with the exception of Computer Studies/Computer Science, where specialist training is essential. This fact, together with the need for computer literacy outlined in paragraph 1.2.1, makes it quite clear that computer awareness and computer literacy together form the most immediate area of concern in the field of computer education. Not only does it lay the foundation required for eventual specialization in the various computer fields of study, but it also provides for an essential educational need which will become increasingly important in the years to come.

2. DEFINITION OF TERMS

2.1 Both the terms "computer awareness" and "computer literacy" are widely used in the literature. Neither of these terms is, however, being used with a uniquely defined shade of meaning. Computer literacy, for instance, is used as a term to describe such diverse programmes as a structured course similar in aims, content and approach to the subject Computer Studies, and for the popular television programme designed and presented by the BBC. It was therefore necessary to look into the various meanings of these terms and to develop descriptions or definitions to serve as a point of departure for all

further investigation and discussion.

2.2 Preliminary operational definitions were formulated to guide the activities of the Committee, with the proviso that these might be changed and adapted as the investigation proceeded and new evidence and insights became available. Eventually the original definitions were retained, namely -

"In the context of this investigation -

COMPUTER AWARENESS will be taken to mean the minimum knowledge required by a citizen to operate with reasonable confidence in a computer-using society;

COMPUTER LITERACY wil be taken to mean the knowledge and skills required to gain an understanding about computers, their uses, application and limitations, and their implications for society."

3. STRATEGIES AND METHODS FOR THE INTRODUCTION OF COMPUTER AWARENESS AND COMPUTER LITERACY PROGRAMMES IN SOUTH AFRICA

3.1 DEFINITIONS OF TERMS USED

The definitions given in paragraph 2.2 above formed the basis of the design group's discussions. It was agreed that the definition of Computer Literacy clearly implied the "hands-on" use of computer hardware.

3.2 THE PLACE OF COMPUTER AWARENESS AND COMPUTER LITERACY IN THE EDUCATIONAL PROGRAMME OF THE SCHOOL

3.2.1 The Committee considered the place of Computer Awareness and Computer Literacy in the total school

curriculum, inter alia, at what stage (age- and/ or standard-level) these programmes should be introduced and up to what stage they should be continued.

Although there are many arguments for and against the very early (preprimary) introduction of computer awareness activities, as well as reports in the literature of the operation of such programmes in practice, these had to be considered in the context of the South African situation and the most immediate and essential educational needs of vast groups of our population.

The Committee arrived at the following conclusions:

(a) Initially it would be unwise to introduce Computer Awareness to school pupils in the preprimary and junior primary phases.

(b) Initially it would be unwise to introduce Computer Awareness on a formal basis to pupils in Standards 2-4 (Grades 4-6) for the following reasons:

1. The concepts handled would not be easily assimilated by pupils at this level. Quite a number of the topics would require higher level thought processes and most of these pupils would not have reached the level of cognitive development required.

2. Many pupils at this level have language difficulties and deficiencies, making discussions almost impossible. Many of them will only at this stage begin mastering the essentials of the two official languages and terminology required will be outside their grasp.

3. In some education departments the teaching of staff involved in this stage, are, from available information, the least qualified and technologically sophisticated, and might find difficulty in putting across the ideas and concepts involved.

4. The amount of appropriate material is not sufficient to spread over a period of three years.

(c) Computer Awareness and Computer Literacy programmes in the school situation should not extend beyond the end of the junior secondary phase (Standard 7 or Grade 9). After this stage further education in computers and computer-related activities could be done

* informally through computer clubs as an extra-curricular activity for interested pupils, and

* formally through further study of Computer Studies as a school subject.

The continuation of Computer Awareness and Computer Literacy programmes after Standard 7 (Grade 9) would -

1. require a higher level of training and in-service training of teachers;

2. necessitate a spiral syllabus progression, leading to the repetition of topics and activities;

3. overlap with the contents of school subjects such as Computer Studies (Computer Study).

3.2.2 "Hands-on" experience

The conclusions arrived at in paragraph 3.2.1 above with regard to the early introduction of Computer Awareness in relation to other more urgent educational needs, were also influenced by the problems and costs pertaining to the provision of equipment for "hands-on" experience in the use of computers.

Although the need for "hands-on" experience cannot be sufficiently stressed, the Committee realises that the provision of hardware and therefore also of "hands-on" experience for all, is perhaps a Utopian dream, but regards it as worth striving for.

In the design of programmes and strategies "hands-on" computer experiences have been included as options, especially in the early stages where the largest numbers of schools and pupils would be involved. The introduction of Computer Awareness should, however, not be postponed because of the lack of hardware. During the initial years of introduction and in the initial stages of instruction, the programmes may be introduced without "hands-on" work being included. However, schools having a computer, or access to a computer, are strongly advised to make use of the options suggested.

3.2.3 LOGO

Having arrived at these conclusions regarding the stage of introduction of Computer Awareness and the problems relating to the supply of hardware, the Committee nevertheless does not wish to prescribe a rigidly defined introductory age or a single approach to the teaching of Computer Awareness and Computer Literacy. The very fact that

computer hardware and education in computers are both such rapidly developing areas, precludes the design of a final plan in this field.

One approach to computer literacy, for which many claims are made, is the so-called "turtle-logic". The best developed of these approaches is LOGO. Because LOGO holds the promise of being one of the best approaches to introducing children to computers from a very early age (c. 4 years) and may be developed in complexity and power in parallel with the development of the child (up to approximately the age of 16 years), the Committee has deemed it necessary to provide additional information, "LOGO as a teaching aid in Computer Literacy", as an addum to this report. (Appendix).

3.3 STRUCTURE OF THE REPORT

The requirements for computer awareness and computer literacy were considered for each of the following groups in turn:

(a) School pupils in Standards 2-4 (or their equivalents).

(b) School pupils in Standard 5 (or equivalent).

(c) School pupils in Standards 6 and 7 (or equivalents).

(d) School pupils in the senior secondary phase (i.e. Standards 8-10, or equivalents).

(e) Teachers-in-training.

(f) In-service teachers.

(g) The non-formal section (i.e. as defined in the HSRC Report on Educational Provision in the RSA .

(h) The informal sector (as defined in the HSRC Education Report).

3.4 RECOMMENDATIONS

3.4.1 School pupils in Standards 2, 3 and 4

The available evidence indicated that initially the priority of this group was computer awareness, rather than computer literacy.

The principal purpose of computer awareness here would be to assist pupils in handling the problems of interfacing with a machine. Thus it would be important to make pupils familiar with the use of keyboards which are becoming increasingly common in everyday life, e.g. money-dispensing machines, railway and other ticket-dispensing machines, typewriter keyboards, hand-held calculators, etc.

3.4.2 School pupils in Standard 5

Because of the difference in training between teachers in Standard 5 on the one hand and those in Standards 6 and 7 on the other, it was agreed that Standard 5 should be seen as a "bridging" year between the end of Computer Awareness in Standard 4 and the beginning of "hands-on" Computer Literacy in Standard 6.

Thus in Standard 5 the great majority of schools would teach Computer Literacy principally via written materials and visual aids such as films. However, for those primary schools which can show that they are in a position (e.g. with competent teachers on their staff) to introduce "hands-on" Computer Literacy,

material support should be provided by the authorities. This support could take two forms:

(a) Further training of those teachers anxious to introduce "hands-on" Computer Literacy, and

(b) financial support for the purchase of micro-computers.

In addition, financial and other support for the national production of appropriate software is particularly important here, although the development of suitable software cannot be limited to this one category of pupils only.

3.4.3 School pupils in Standards 6 and 7

3.4.3.1 It is recommended that in Standards 6 and 7 Computer Literacy should be taught in a more formal manner using hardware supplied wholly by the Education authorities.

However, to delay the introduction of a Computer Literacy programme for these standards until computer hardware (and the 220 volt-electrical supply required to operate it), is available in all schools throughout the country, would be most unwise.

It is therefore recommended that initially there should be two "levels" of Computer Literacy in Standards 6 and 7:

LEVEL 1: For schools with no or inadequate trained staff, a "non-hands-on" literacy course using television and/or written material, supported if possible by audiovisual media, should be introduced.

LEVEL 2: Where a school has staff necessary to

introduce "hands-on" Computer Literacy, it should be supplied with adequate quantities of computing equipment and the course introduced as soon as possible.

In determining the "adequate quantities of computing equipment" referred to above, the number of microcomputers (or terminals) per school should be calculated according to the following formula:

½ (the largest class in the school) + 3, plus 1 for the teachers and to replace any "down" machines.

3.4.3.2 On the basis of experience gained locally and as reported in the literature, it is further recommended that Computer Literacy at the Standard 6 and 7 level should receive the equivalent of 12 to 15 contact hours per year, excluding "hands-on" experience.

3.4.3.3 It is recommended that the provision for teacher training and in-service training will be co-ordinated in such a way that there will be a steady movement of schools from Level 1 to Level 2.

3.4.3.4 Itinerant Teachers

It was accepted that because of the logistic problems of training the large numbers of teachers involved in such a programme, serious consideration should be given to making use of a small number of itinerant teachers specially trained for the purpose. Each such teacher would handle a group of schools in a particular geographical area, as, according to the literature, has apparently been done with considerable success in Australia. These itinerant teachers would fulfil the dual function of handling computer literacy courses for pupils and at the same time training the

staff of the schools concerned. If the schools concerned do not possess their own microcomputers, these could be brought to the school by the itinerant teachers. Suitable, easily portable models are available. Appropriate films could make a major contribution to the implementation of such a programme.

3.4.3.5 Regional Computer Centres

At the same time serious consideration should be given to the establishment of regional computer centres to which pupils from schools with no computing equipment can be transported for the equivalent of one working day per year. Such centres would also serve as valuable institutions for teacher training in Computer Literacy.

3.4.3.6 Subsidised purchase of microcomputers by schools

In many countries powerful incentives are in force in order to introduce computers into schools. Thus in the United States the Technology Education Act of 1982 offers substantial tax deductions to companies that donate computers to schools[1] while in the United Kingdom the British Government has set aside £9 000 000 to subsidise the introduction of computer materials on a £-for-£ basis.[2]

3.4.4 School pupils in Standards 8-10

In standards 8-10 the pressure of a full curriculum

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1) Classroom Computer News, Volume 3, Number 2, November/December 1982.

2) British Business, July 23, 1982.

of examination subjects means that Computer Literacy as such would be inappropriate. In these standards, therefore, "computer activity" would take the form of either Computer Studies as an elective subject and/or Computer Clubs.

However, every effort should be made to bring to the notice of pupils in the senior secondary phase the value of the computer in a wide variety of disciplines. This could best be achieved by adding to most school subjects a topic reflecting the particular applications of the computer in that subject.

3.4.5 Initial Teacher Training

3.4.5.1 The Committee accepted that in order to teach effectively the teacher must initially know more than his pupils. However, the nature of computer education is so "open-ended" that individual pupils with the aptitude, ability and interest may rapidly develop beyond the scope of a computer awareness or computer literacy programme, or may pursue a particular line of interest within the computer field, so that it would be unrealistic to expect of the teacher to keep abreast of all the possible topics and developments. Thus to teach Computer Awareness in Standards 2-4, and even "non hands-on" Computer Literacy in Standard 5, primary school teachers must all receive training in both Computer Awareness and Computer Literacy during their diploma or degree studies, including "hands-on" contact with computers during his/her training period.

Because of the grave shortage of college of education staff able to teach such courses, it is recommended that such staff should receive training at the Universities on a full-time release basis for a period of 100-150 contact hours.

3.4.5.2 Because of the increasingly important role of computers in education, it is recommended that all secondary school teachers should undergo a course in "hands-on" Computer Literacy during their post-graduate HDE year, or its equivalent.

3.4.5.3 It is further recommended that the courses outlined in 3.4.5.1 and 3.4.5.2 above be included in the statutory requirement criteria for all approved teachers' diplomas, integrated degrees and certificates.

3.4.6 In-service Teachers

3.4.6.1 Because of the very large numbers of teachers involved in any teacher in-service training programme, it is recommended that a "two-layer" approach be adopted:

(a) A course in Introductory Computer Literacy, planned jointly by the SABC and the educational authorities, which would consist of a series of television programmes broadcast on all channels of the public television system and also available on video cassette tapes. These programmes would be supplemented by two manuals:

(1) One intended for those members of the general public who will be following the programme (See 3.4.7 below), and

(2) one written especially for teachers.

(b) This would be followed by a "hands-on" course for teachers, such courses being held at Universities, Colleges of Education and, possibly, Technikons. Entry into such a course

would be dependant upon the candidates showing that they had successfully completed the work of the theoretical course in (a)(2) above. This selection could take place by requiring teachers to complete and submit for marking a series of regular multiple-choice tests. This mechanism would provide a means of reducing the numbers of teachers proceeding to the "hands-on" course.

3.4.6.2 The Committee is aware that there will inevitably be a period of delay until the recommended scheme is in operation. It is recommended that, during this interim period, all in-service training courses, in all examination subjects, should include a component of computer awareness. In addition it is recommended that all Teachers' Centres, or other institutions for the further training of teachers, run a regularly repeated series of lectures or courses on Computer Awareness and Computer Literacy as frequently as possible.

3.4.6.3 Finally, it is recommended that immediate attention be given to the preparation and widespread publication of a series of booklets directed at subject teachers, e.g. "The Role of Computers in Geography (Accountancy, Mathematics, etc.) Teaching".

3.4.7 Non-Formal Sector

The Committee agreed that Computer Literacy Programmes for the Non-formal Sector (e.g. Commerce and Industry) would, for obvious reasons, vary considerably in emphasis. It is therefore recommended that such a programme should consist of the public television programmes (and video cassettes) and the basic manual mentioned in 3.4.6.1(a)(1), supplemented by a series of manuals written with the

needs of specific industries or commercial operations in mind.

3.4.7.2 It is further recommended that a core programme in Computer Literacy for the Non-formal Sector be designed and that this core also serve as the criterion for registration as a training scheme with the Department of Manpower in terms of Article 11 sept of the Income Tax Law, 1962.

3.4.8 Informal Sector

The following suggestions dealing in detail with this topic, should be considered.

3.4.8.1 The subsidised publication, for widespread distribution or sale throughout South Africa, of an attractively produced and readable computer-awareness booklet "What are Computers," of, say, 50 pages in length and priced at not more than R1.00.

3.4.8.2 The basic manual referred to in 3.4.6.1(a)(1) above should if possible be written on a "stand alone" basis for those members of the public who do not possess television receivers.

3.4.8.3 The SABC-TV computer-literacy programmes referred to in 3.4.6.1(a) should be widely available in the form of video cassettes (subsidised if possible).

3.4.8.4 The assistance of the Computer Society of South Africa should be sought in designing any national programme for Computer Awareness or Computer Literacy.

3.4.8.5 Community Computer Clubs are an important avenue for the introduction of computer literacy. Serious consideration should be given to subsidising such

clubs, either from government funds or via the computer industry. (National support for less important organised activities such as sport is already accepted and practised.)

3.4.8.6 Software for Computer Literacy is often inappropriate for South African conditions, e.g. poor English, not in Afrikaans, not SI, etc.

Here consideration should be given to producing our own software as soon as possible. However, as this will take some time, appropriate overseas software, such as the Science Research Associates (SRA) materials, can be used in the meanwhile.

The Committee favours the production of such software on a decentralized basis, e.g. at universities (via a centralized funding body) rather than at a large national centre. The Committee is in favour of a centralized distribution agency for such software.

4. OUTLINE PROGRAMMES FOR COMPUTER AWARENESS AND COMPUTER LITERACY

4.1 AIMS OF A COMPUTER AWARENESS/LITERACY PROGRAMME

Generally speaking, the programme is aimed at dispelling the mystery associated with computers and to achieve the knowledge, skills and understanding set out in the definitions in paragraph 2.

The course has been designed using the following criteria as a basis:

* Stress is laid on understanding computer concepts rather than specific details.

* Although "hands-on" experience is regarded as the ideal, the design makes provision for the fact that this will probably not be possible for all schools during the initial years.

* The needs of the school-leaver have specially been borne in mind.

* The needs of the employer have been taken note of, but only in as much as the Computer Literacy Programme will form part of vocational guidance.

4.2 DESIGN PHILOSOPHY

Difficulties in obtaining hardware and suitable software will inevitably lead to problems in the presentation of the programme at school level. Thus the concept of a core with options has been proposed.

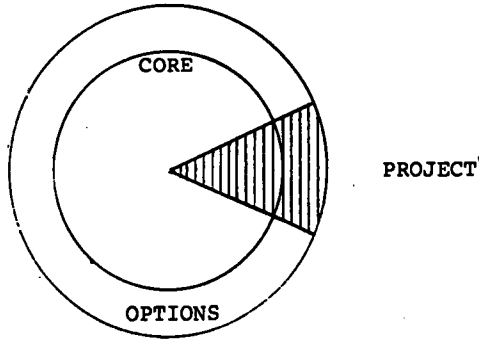

FIGURE 1

The core will contain the minimum that a pupil at a particular level should know. Optional material will be included more as an extension of the core than as something new. It was agreed that the one way in which the options could be included in the overall design would be to set

each pupil or group of pupils a project which takes core material as a starting point and then expands upon it. Thus "hands-on" computer time could be included as an option for those schools having computers or terminals.

In the design of the course general computing principles have been stressed rather than specific areas. This allows for a greater flexibility in method and hardware used.

4.3 THE SCOPE OF THE PROGRAMME

In the programme design the Committee has not drawn a definite line between Computer Literacy and Computer Awareness. Thus the topic introduced will start off at a relatively superficial level and increase in depth as the programme develops; there will thus be a natural flow from Computer Awareness into Computer Literacy, and from there into Computer Studies and Computer Club activities. The programme, and Computer Studies, could all run in parallel with a Computer Club which all schools must be encouraged to establish.

The seven topics selected cover the following areas (see Figure 2):

* Technophobia: Designed to reduce the fear that some people have of modern technology

* Systems : Hardware: An introduction to computers and micro-processors.

  Software: Learning to use computers.

* Applications : The following areas should be considered: Home, business, scientific, industrial, educational, etc.

* Implications : The implications for business, education and society.

* Careers : Advice and information on the various careers in computing.

* History : This could be tied to the first topic as fear is usually reduced if one knows where the object of one's fear originated.

* The future : A discussion of the latest and possible future developments and applications.

SCOPE OF THE COURSE

COMPUTER AWARENESS/COMPUTER LITERACY

Technophobia	Systems		Applications	Implications	Careers	History	The Future
Use Computers	Hardware	Software	Home:	Society in general	Management	Development of computers	Robotics
	Black-box level	User Software	Business: Computicket Autobank Building Society	Business and Industry	Hardware design	Historical aspects	Artificial Intelligence
					Sales		
		LOGO		Education		Important people and events	
		Systems	Scientific: Monitoring Control		Software design Education		
			Industrial: Robotics CAD				
			Educational: Training devices CAI				

FIGURE 2

4.4 TEACHING STRATEGIES

Because qualified teachers will, for the immediate future, be in short supply, it is suggested that in the primary school area, at least, the programme could be presented using the thematic approach. Thus the teacher would provide computer topics for theme-work and the pupils would do a large proportion of the work themselves. Such an approach would help to spread the load and a new subject would not have to be introduced. One teacher, trained in the presenting of Computer Awareness/ Literacy programmes, would co-ordinate the work and possibly handle the "hands-on" aspects.

The resumé of the programme presented in paragraph 4.8 will adopt this policy. The historical aspects may be handled by the History teacher; the Language teachers might introduce the writing of instructions, etc.

Rôle-play is suggested as a means of putting across the ideas involved in the operation of the computer. This could be a classroom activity.

The section on computer applications would best be handled by allowing pupils access to industrial concerns, businesses, schools making use of microcomputers, banks using money-changing machines, etc.

In secondary schools the presentation of the programme would best be left to specially trained teachers, preferably with some computing background.

4.5 TEACHING MATERIALS AND RESOURCES

The Committee was of the opinion that the programme would not succeed unless suitable resources were

made available to the teachers. The various Education Departments should strongly consider the release of teachers in various subject areas to do research on computer topics falling in their sphere of interest. Each subject group would publish reports for distribution to schools for use in the Computer Awareness/Literacy programme.

It is recommended that the co-ordination of the various report writing groups should be carried out by the proposed "Central Clearing-house". The "Central Clearing-house" should also investigate the acquisition of the following:

* Slide/tape sequences (A series of slide/tape sequences is available from the University of Wyoming, USA. The three sequences are:

  COMPUTERS Where are they found?

  COMPUTERS What do they look like? How do they work?

  COMPUTERS Anatomy of a microcomputer.

  Video presentations (BBC series; Mighty Micro, SATV, etc.)

* 16 mm Films (Obtainable from the larger computer vendors.)

* Computer software (Along the lines of the SRA Computer Literacy Course.)

* Publication of a newsletter containing updating and new information which would help the teacher.

4.6 MICRO-PROCESSOR CONTROLLED OBJECTS

It is recommended that, wherever possible, use could

be made of any or all of the following objects:

* Graphics : "BIG-TRAK"
  "LOGO" Turtle
  "BBC BUGGY"

* Calculators : "Little Professor"
  "Speak 'n Spell"
  "Speak 'n Maths"

* Vending machines : tickets

* Automatic tellers

* Computers in cars

* Home appliances : Microwave ovens
  Washing-machines

* Point-of-sale terminals : Cash registers
  Bar-code readers
  Electronic balance/calculators

4.7 VISITS

Visiting businesses and industries making use of computers and computer-controlled equipment should receive a high priority. The following is a list of possible places of interest:

* Car assembly plants utilising robot construction

* Computer cataloguing in libraries.

* Manufacturing industries utilising computers, e.g. oil refineries.

* South African Travel Services (Railways Computer System: SAA Booking System).

* "Computicket".

* INFO.

* BELTEL and other Post Office facilities (e.g. mail-sorting, electronic telephone exchanges).

* Computer exhibitions.

4.8 OUTLINE PROGRAMMES

The Committee has, as far as possible, endeavoured to break down the topics listed in paragraph 4.3 into subject areas and to give an indication of the content to be covered. It is reiterated that the intention is for most of the work to be done on a thematic or project basis. The themes/projects should then be discussed in the class/group. We emphasise the need to keep these themes within the child's frame of reference ("world-view").

4.8.1 Standard 4 (Grade 6)

History:

* Historical characters involved in the development of computers and data-processing, e.g. Pascal, Napier, Babbage, Jacquard, Hollerith, Van Neumann, Boole, Turing, Lovelace. This could possibly be incorporated in the History section on "Heroes of the 20th Century".

Mathematics

* Executing procedures for a familiar task. The procedure should involve decisions, e.g. long division algorithm.

* Finding and correcting errors in a given procedure.

* Modifying procedures to make them accomplish new tasks.

* "Grid-location".

* "Journeys" - setting up a series of directions to accomplish a specific task, e.g. locating pirates' treasure on a treasure map.

Science

* Calculators (programmable, c.g. "Little Professor").

* Dispensing machines (money, tickets).

* Electronic washing-machines, etc.

* Life-cycles of animals.

Languages:

* Writing out lists of instructions to achieve a particular task, e.g. using a telephone, frying an egg, etc.

Geography

* As a tool in neighbourhood geography - "Computers in our neighbourhood" (e.g. visits to businesses in the neighbourhood using computers).

Book Education

* Procedures involved in checking-in and checking-out library books.

* Computerised book catalogues.

Option

* LOGO: - Familiarisation with

  ** Loading LOGO
  ** Keyboard

  ** Turtle Commands

  - Drawing elementary geometrical shapes.

* High-level languages

  Those pupils wishing to learn BASIC, PASCAL or any other language should be actively encouraged.

4.8.2 Standard 5 (Grade 7)

History

* Code-breaking during the war - leading to the need for computers.

* Development of simple codes.

* Gunnery during the war.

Mathematics

* Develop and de-bug procedures for familiar tasks, e.g. long multiplication.

* "Journeys" - more complex than before.

* Simulation - in money matters, e.g. "Lemonade".

Science

* Classification of animals and plants, e.g.

dichotomous keys.

* Categorising items.

* Food-chain simulations.

General

* The computer used in Mathematics, Science and other subjects for drill, practice, simulation, etc.

Option

* LOGO - continuation of previous work extending to graphical work.

* High-level language.

.8.3 Standards 6-7 (Grades 8-9)

Note

For this phase the topics have not been compartmentalised into different subject areas, as the intention is for a teacher trained in Computer Awareness/Literacy to handle the instruction.

Top-down design:

* The principle of breaking down a task into subtasks is to be stressed (this can be covered in many of the scientific/mathematical areas if necessary).

Procedures

* General procedures for sorting and searching.

Simulation

* Areas of application are History, Science, Biology, Geography, Mathematics.

Data-bases

* Classification of books in a library and of plants and animals in Biology.

Social implications

* Possible disappearance of cash.

* Privacy of information.

* "Computer fraud".

Animation:

* Computer-generated cartoons.

* Full-length movies (e.g. TRON).

Project approach:

* Design and execution of a project (e.g. the "Kennel project" in Fred learns about computers, MacDonald and Evans) with the following objectives:

  - Pupils should become familiar with aspects of computing relating to small businesses.

  - They should be made aware of alternative possibilities

  - They should understand the concept of multi-tasking

Elementary computer architecture

* Limited to the "black-box"level. (This could be done using rôle-play).

High level languages

* Extension to non-graphical areas emphasising the procedural design.

.9 EXTENSIONS TO THE OUTLINE PROGRAMMES

.9.1 Standard 3 (Grade 5)

Pupils at this level should be exposed to computers as users. They should be permitted to play educational games and use simulation where necessary.

.9.2 Standards 8-10 (Grades 10-12)

The intention here is not to extend the Computer Awareness/Literacy programme to this phase as pupils will be concentrating on their major school subjects. However, the Committee expressed concern at the fact that syllabuses already teaching something about computers (Accountancy and Mathematics) were outdated and that these required immediate and constant revisions, and that the teacher urgently needed support.

Where computers can be used to improve the teaching situation, teachers should not hesitate to use the Examples can be drawn from many subjects, e.g.

* simulation in Physics, Chemistry, Biology, Geography

* word processing

* company books in Accountancy

Computer Clubs should be established to cater for pupils who are interested in the "hands-on" aspects of computing. These clubs could also deal with aspects of electronics and the interfacing of computers with various scientific experiments.

The school guidance services must include computer-orientated careers in their guidance programmes.

4.10 FUTURE DEVELOPMENT

The Committee recommends urgently that the contents of Computer Awareness/Literacy programmes be continually updated and renewed when necessary. This means that the revision of the contents must be an ongoing task. Latest innovations must be introduced as soon as possible and not be left for some future revision as appears to be the case with many other school syllabuses. The task of disseminating new contents would best be handled by the "Central Clearing-house".

5. ADMINISTRATIVE PROCEDURES FOR THE INTRODUCTION OF COMPUTER AWARENESS/LITERACY

A great many Government and Provincial Departments, associations, bodies and institutions would have to be involved in the implementation of a strategy for the general introduction of computer awareness/literacy programmes for all sectors of the community. These are mainly the following:

5.1 School education and the training of teachers

5.1.1 Primary and secondary schools

5.1.1.1 Department of National Education

5.1.1.2 Cape Education Department

5.1.1.3 Natal Education Department

5.1.1.4 O.F.S. Department of Education

5.1.1.5 Transvaal Education Department

5.1.1.6 Department of Internal Affairs: Coloured Education

5.1.1.7 Department of Internal Affairs: Indian Education

5.1.1.8 Department of Education and Training

5.1.1.9 Conference of Headmasters and Headmistresses

NOTE

5.1.1.1 - 5.1.1.5: General implementation of any new educational programme by these departments is co-ordinated through the Committee of Heads of Education.

5.1.2 Initial and in-service training of teachers

5.1.2.1 Teachers' Colleges:

All education departments listed under 5.1.1.1 - 5.1.1.8 above.

5.1.2.2 Universities

All universities involved in teacher training.

5.1.2.3 Technikons

All technikons involved in teacher training.

5.1.2.4 In-service training

All departments listed under 5.1.1.1 - 5.1.1.8 above.

NOTE:

Many of these departments often plan courses in collaboration with universities, university institutes and colleges.)

5.2 TERTIARY EDUCATION (EXCLUDING TEACHER TRAINING)

5.2.1 Universities

5.2.2 Technikons, technical colleges and technical institutions

5.2.3 Agricultural colleges (including Forestry)

5.2.4 Training centres offering advanced (post Standard 10) courses.

5.3 NON-FORMAL EDUCATION

5.3.1 Government Departments and institutions, e.g. training centres of the Department of Manpower, Saasveld College, S.A. Police College, training institutions of the S.A. Transport Services, Department of Post and Telecommunications; Provincial Administrations; local authorities.

5.3.2 Commerce and industry

5.3.2.1 Training schemes of semi-government institutions and companies.

5.3.2.2 Training schemes of private employers registered with the Department of Manpower.

5.3.2.3 Chambers of Commerce, Chambers of Industry, Chamber of Mines.

5.3.2.4 Computer companies, importers and dealers: As a client service.

5.3.2.5 Computer Societies, Computer Users Associations, Computer Services Bureaux, Computer Dealer Associations, Associations of Computer Teachers, etc.: As a service to members.

5.4 INFORMAL EDUCATION

5.4.1 Departments/divisions of Adult Education, Further Education, Extramural Studies, etc. of

* The Department of National Education
* Department of Internal Affairs
* Department of Education and Training
* Universities

5.4.2 SABC, especially SABC-TV 1, TV2 and TV 3.

5.4.3 Post and Telecommunications, especially in providing communication facilities.

5.4.4 Private Computer companies, associations and computer "schools" run by these companies and associations.

5.5 PROCEDURES FOR THE INTRODUCTION OF COMPUTER AWARENESS/LITERACY PROGRAMMES IN SCHOOLS

5.5.1 <u>Education for Whites</u>

The general implementation of any addition to or

change of the school curriculum must be approved by the Committee of Heads of Education. Programmes offered by private schools are coordinated through the Conference of Headmasters and Headmistresses.

5.5.2 Coloured and Indian Education

The school curriculum is the responsibility of the Department of Internal Affairs. Usually the lead of the Committee of Heads of Education is followed in respect of most school subjects.

5.5.3 Black Education

The Department of Education and Training is responsible for the school curriculum. Here again the pattern set by the Committee of Heads of Education is followed for the senior secondary phase, but curricula for the primary standards differ considerably.

5.5.4 Teacher training

5.5.4.1 Initial training of teachers for Whites

For the inclusion of a compulsory Computer Awareness/Literacy component in the curricula for teacher-training courses at colleges and universities, this component must be included in the "Criteria for the Evaluation of South African Qualifications for Employment in Education". Amendments and additions to these criteria are considered by the Committee of Heads of Education through its subcommittees, the IACEQ and IAQT.

5.5.4.2 Initial training of teachers for Coloureds and Indians

The criteria for recognised qualifications for these teachers are set by the Department of Internal Affairs.

5.5.4.3 Initial training of teachers for Blacks

The criteria for teachers' qualifications are set by the Department of Education and Training.

5.5.5 In-service training for teachers

All in-service training is initiated by the education departments concerned.

5.5.6 Tertiary education

5.5.6.1 Universities

Being autonomous institutions, universities, as a rule, decide individually on the introduction of ancillary courses. Representations for the general introduction of Computer Literacy courses or modules may, however, be made through the Committee of University Principals and the Committee of University Rectors.

5.5.6.2 Other tertiary institutions fall under the control of various government departments, mainly the Departments of National Education, Internal Affairs and Education and Training.

5.5.7 Non-formal education

The general introduction of Computer Awareness/Literacy in the non-formal sector, is fraught with difficulties. Because of the wide range of inte-

rests and organisations involved, there is no simple mechanism or procedure available. However, since commerce and industry are usually fairly quick in adapting to the demands of new technology, it is expected that such courses for employees will follow as the need arises.

5.5.8 Informal education

The same trend envisaged in the case of private enterprise, may be expected in respect of adult education programmes offered by universities, technikons and similar institutions. These institutions usually are able to cater for current public demands and interests at short notice.

For the computer education for the public at large, the media, and especially television and radio broadcasting, are the vehicles par excellence for furthering computer awareness/literacy.

5.5.9 General recommendations

Any strategy or plan for the introduction of computer awareness/literacy for all levels and sectors of the South African population would require the co-operation of a wide variety of official and non-official bodies. In addition, it should be made possible and worthwhile for private enterprise to invest in this effort, both by participation in the programme for their own employers and by financial incentives, such as tax benefits, for the donation of hardware to educational and training institutions.

It is also essential that in the planning of radio and television programmes the closest and most beneficial co-operation between educationists and the SABC should be brought into effect. Other media should be involved as well, and to supply

them with the necessary information for dissemination to the public, the establishment of a "Central Clearing-house" is essential.

It is recommended that care should be taken to involve the appropriate authorities at even the earliest planning stages. In this regard it would be advisable to invite every interested party or organization to a national launching conference in order to inform them about the rationale and extent of the programme and to involve them in its planning.

6. PRIORITIES

Because of the multifaceted approach to the introduction of computer awareness/literacy, it is not possible to recommend a simple sequential priority order. Many aspects need to be initiated simultaneously.

The following order is therefore recommended:

1. (a) Schools programme:

   Submission to the appropriate authorities for approval of national curricula for initial teacher training and the inclusion of a compulsory computer-literacy component or module in the criteria for teachers' training courses.

2. The training of trainers, i.e. college lecturers, lecturers at faculties of education, teachers selected for presenting in-service courses, and itinerant teachers.

3. (a) Introduction of Computer Literacy in teacher-training courses at all training institutions.

(b) In-service training of teachers (first phase).

(c) Introduction into schools in Standards 4 and 6 (Grades 6 and 8) and subsequently in Standards 5 and 7 (Grades 7 and 9).

(d) Negotiations with the SABC with the view to design and presentation of Computer Awareness/Literacy programmes for the public and as support for the teacher-training programme.

NOTE:

This is not related to the investigation regarding BELTEL, etc.

(e) The appointment of writing teams and the preparation of preliminary documents.

4. Software development.

5. Supply of hardware to schools.

The implementation programme is schematically represented in Figure 3.

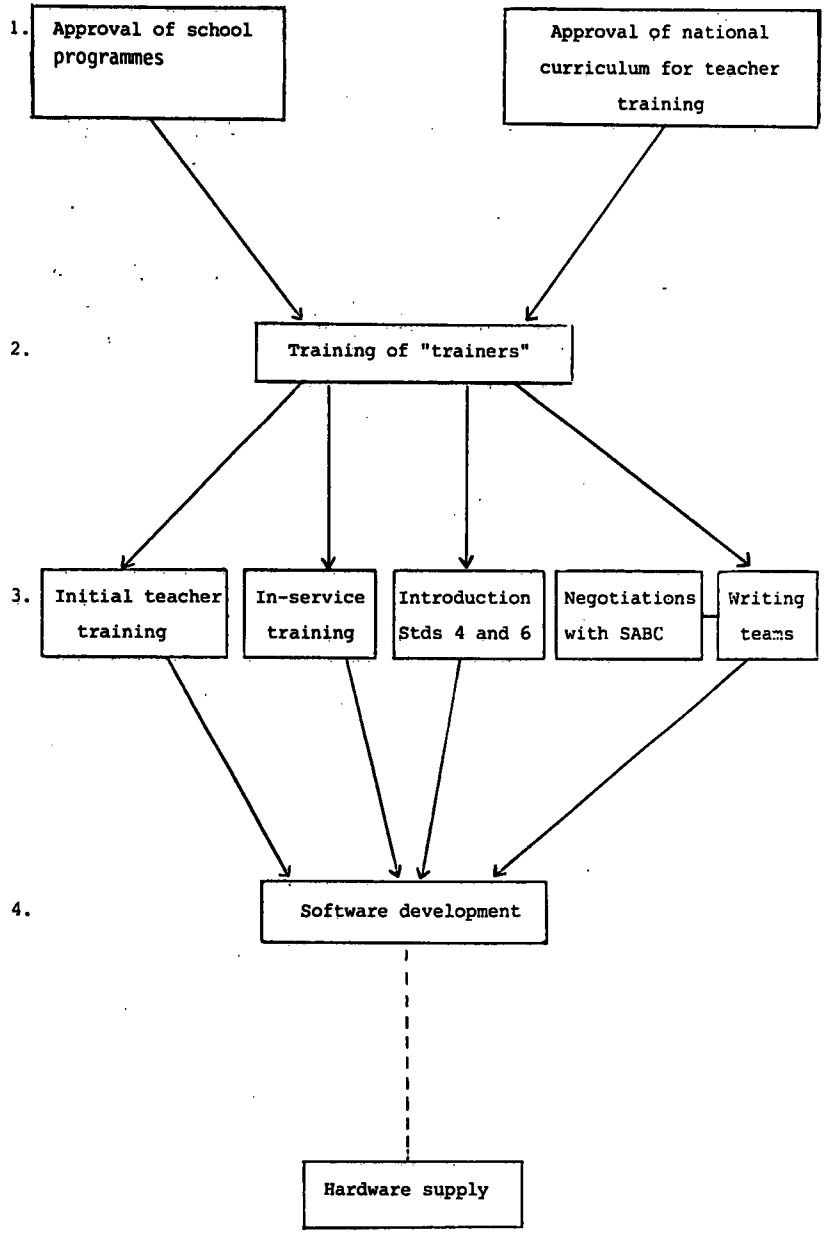
1.
Approval of school programmes
Approval of national curriculum for teacher training
2.
Training of "trainers"
3.
Initial teacher training
In-service training
Introduction Stds 4 and 6
Negotiations with SABC
Writing teams
4.
Software development
Hardware supply

FIGURE 3

7. SELECTED BIBLIOGRAPHY

Notes

1. Due to the extremely rapid development of ideas, it was decided to present the bibliography by YEAR order, rather than alphabetically by author. Within each year it is presented alphabetically.
2. There has been a very large number of publications since the introduction of microcomputers (the ERIC search produced well over 200 documents). Consequently, the bibliography has been limited to those publications that appear to reflect genuine research findings or topics of particular interest.
3. Two important groups of publications have not been included in the formal bibliography as these publications were referred to in draft form only.

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   This is a very comprehensive study of the aims and objectives of computer literacy and includes learning materials, computer programs and classroom activities.

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   A detailed study of computer studies, including computer awareness.
4. A separate section is included in LOGO.

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APPENDIX

LOGO AS A TEACHING AID IN COMPUTER LITERACY

"The first computer language your learn has a life-long effect on how you think, computerwise. Thus the computer language we choose for the use in schools becomes vital. I believe, ... that LOGO is a much better language to use for introducing children to computers than say, BASIC" (Chris Morgan, Editor in Chief, Byte, August 1982).

1. WHAT IS LOGO?

1.1 The language

Logo is a LISP-like, procedure orientated computer language. (LISP is a computer language developed as a part of research into artificial intelligence).

1.2 The Philosophy

The Logo language was born out of a particular educational philosophy and is now the central feature of a growing group of researchers and computer language movements that loosely follow that philosophy. The Logo movement is growing fast and "Mindstorms" (Papert, 1980) has become the handbook for the movement.

According to the Logo philosophy, the computer should be a tool for discovery; a tool which expands guided by the mind of the learner. Children should programme computers - computers should not programme children.

Papert says "in teaching the computer how to think, children themselves think. The experience can be heady. Thinking about thinking turns the child into an epistemologist, an experience not even shared by most adults" (1980:19).

2. HISTORY OF LOGO

2.1 Piaget

During the years 1959 to 1964 the ex-South African, Seymour Papert, worked at Piaget's Centre for Genetic Epistemology in Geneva. Papert was impressed by Piaget's research and his theories. He recognized the validity of Piaget's distinctions between concrete thinking (Age 6+) and formal thinking (Age 12+).

> "In 1964, after five years at Piaget's Centre for Genetic Epistemology in Geneva, I came away impressed by his way of looking at children as the active builders of their own intellectual structures. But to say that intellectual structures are built by the learner does not mean they are built from nothing. On the contrary, like other builders, children appropriate to their own use that which they find about them, most saliently the models and metaphors suggested by the surrounding culture" (Papert, 1980:19).

2.2 M.I.T.

During many years at the Artificial Intelligence Laboratory at the Massachusetts Institute of Technology, Papert and his colleagues developed Logo.

Originally Logo was developed to help with the teaching of mathematics to young children. The original versions had line numbers like BASIC, but otherwise with many of the features of LISP. The language was designed to be used with very young children - as young as 6 - and would allow them to do what they do best - learn language. The use of a physical and a symbolic turtle should bridge the gap between concrete and formal thinking. Logo provides the young learner the "object-with-which-to-think" and the possibility to apply processes learned in that way to more abstract situations.

> "Stated most simply, my conjecture is that the computer (LOGO) can concretize (and personalize) the formal. Seen in this light, it is not just another powerful educational tool. It is unique in providing us with the means for addressing what Piaget and many others see as the obstacle which is overcome in the passage from child to adult thinking. I believe that it can allow to shift the boundary separating concrete and formal. Knowledge that was accessible only through formal processes can now be approached concretely" (Papert, 1980:12).

As Papert puts it: "The idea of programming is introduced through the metaphor of teaching the turtle a new word" (1980:12).

2.3. Mindstorms

Logo, in its many versions, has been around for many years, but it only came to the notice of the international community with the publication of "MINDSTORMS" (Seymour Papert, 1980). The book, with its catchy title, helped to create a virtual Logo cult from Tasmania to Alaska.

> "Mindstorms shows how the fundamental concepts of mathematics can be understood and mastered by young children through the use of the techniques outlined here in detail. Papert describes how the system works, how the children learn and progress in exciting and mind-boggling leaps, and relates the experience to cognitive development - especially to theories of Piaget. Papert takes a hard look at the way in which Maths Phobia is created in classrooms and can be overcome with the help of computers" (Computer Age, 1981).

Papert himself has now left M.I.T. and has joined Jean-Jacques Servon-Schreiber's World Computer Centre in France as chief scientist.

3. WHY LOGO IS DIFFERENT FROM OTHER COMMONLY USED COMPUTER LANGUAGES

Back in the 1960's when computers were big in size and small in memory, programming languages had to be designed to fit the memory available - at the expense of several restrictions on the programmer. The personal computers

of the late 1970's were as restricted in their memory. Somehow the restriction of languages like BASIC, became to be seen as virtues. (It enforced a programming dicipline, it contained few primitives and must therefore be easy to learn.)

In the development of Logo, the restriction of memory size was largely ignored and a procedural language based on LISP was created. A Logo program is really a cluster of procedures which are defined in terms of primitives or other procedures.

Now that memory is no longer a restricting factor, we find that most newly developed programming languages are procedurally organised.

4. LOGO AS A PROGRAMMING LANGUAGE

Although Logo's success as an aid to teaching mathematics is still very much in debate, it is proving its value as an introduction to programming. Logo has many features which make it an attractive programming language:

Brian Harvey (Byte, August 1982, p.163) lists the following characteristics of Logo:

* Procedural
* Interactive
* Recursive
* Iteration
* Listing Processing
* Lists are not Typed
* Extensible
* Designed for Concrete Applications
* Designed for Beginners
* User-friendly
* Suitable for all ages.

4.1 Logo is Procedural

A problem is divided into small pieces and a separate procedure is written for each piece. In this respect Logo is like most modern languages such as Pascal, APL, C and even FORTRAN. Among the more popular general-purpose language only BASIC lacks this capability.

4.2 Logo is Interactive

Logo lets one type in a command to be carried out immediately. BASIC, LISP, FORTH and APL also allow this, but it is not possible with Pascal, C and FORTRAN. (Logo uses an interpreter instead of a compiler and should therefore be a "slower" language. Considering the intended use of this is of little importance).

4.3 Logo is Recursive

In all procedural languages one procedure can use another procedure as a sub-procedure. A language is recursive only if a procedure can be a sub-procedure of itself. All modern procedural languages like Pascal, LISP, C and APL allow recursion. FORTRAN allows procedures but no recursion. BASIC allows neither procedures nor recursion. Recent versions of Logo allow tail recursions.

4.4 Logo allows Iteration

Although Logo encourages the use of recursion, iteration similar to the 'FOR ... NEXT' statement in BASIC is possible.

4.5 Logo has List Processing

The data structures in Logo are based on those of LISP. Each element of a Logo list can be any Logo object: a number, a word or even another list. Other languages also have the ability to group information together, but usually subject to more limitations. FORTRAN, BASIC, Pascal and C use arrays which must be uniform and of fixed size. Pascal "records" and C "structures" allow non-uniform groupings, provided that they are in a pre-declared pattern. APL uses a data structure which allows a freedom of size, but requires uniform grouping. Non of these limitations apply to Logo.

Logo allows lists within lists. These lists can be handled as first class data objects: They can be:

* assigned the value of variables
* passed as inputs to procedures
* returned as outputs from procedures
* manipulated by operations
* picked for random items
* joined and/or dissected.

4.6 Logo Lists are not Typed

In BASIC, FORTRAN, Pascal and C, the type of variable must be stated explicitly e.g. A$ or A%. In Logo LISP and APL any variable can take on any value.

4.7 Logo is Extensible

An extensible language is one which user-defined procedures "look" and act like primitive procedures. Almost all languages allow the programmer to create new operatives, but in most of those newly created procedures must specify the particular type of variable to which they apply and are thus not truly extensible.

With some minor restrictions LISP, APL and FORTH are also extensible.

4.8 Logo is Designed for Concrete Applications

Whereas the graphics of languages like Pascal and BASIC are more difficult to handle than the language itself - at least for children who learn to programme - Logo is introduced through graphics. Through the use of a physical turtle which carries out computer commands the programme is made concrete. The use of a screen turtle helps the pupil to bridge the gap between the concrete and formal. The turtle is a powerful learning tool because of the way it describes lines relative to the position and direction of the turtle and not according to co-ordinates as in other graphic systems. Turtle geometry is close to the child's experience and natural language use:
"To reach the ... you turn left, walk ten paces and then right ...

4.9 Logo is designed for Beginners

BASIC and the high level language have a "minimum knowledge" threshold to cross before the learner can tackle interesting problems. Even then the "interesting" problems tend to be very biased in the algebraic direction. Logo overcomes this problem by using turtle geometry and the ability to handle "mixed" lists.

4.10 Logo is User-Friendly

4.10.1 Errors are handled by a helpful error message. The command "JUMP" will result in the error message: "I DON'T KNOW HOW TO JUMP."

4.10.2 Logo uses the color (called "dots") to call for the value of a variable. The same words without the "dots" may be used to name a procedure. Most procedural languages would not allow the use of the same word for both purposes. LISP allows it, but only through parenthesis which themselves are difficult to use.

4.10.3 Respecting the ingrained habits of its users, Logo makes provision for in-fix and pre-fix arithmetic: i.e. "4 + 5" and "SUM 4 5".

4.10.4 A visible editor which can be moved round the screen by using special keys to make editing easy.

4.11 Logo is Suitable for all Ages

Although Logo has become known as a children's language, it is suitable for learners of any age. Up to now, no serious problem solving using Logo has been attempted, but it has been used to write simulation programmes in Physics for M.I.T. Undergraduates.

With a specially adapted keyboard and the turtle children as young as 4 can write programmes.

5. DIFFERENT LOGO'S

Logo means different things to different computers

The M.I.T. versions of Logo as they developed over the years all needed the support of a mainframe computer. There are fairly complete versions of Logo available for micro-computers now. These versions need at least 48K but preferably 64K of memory to support them. Most micros do not have that size memory available, and we find that versions of Logo are marketed for those machines which include only the graphic introduction to Logo, and not the language itself.

One way to get round the problem of memory size is to make special Logo ROM packs available which plug into the machine. Not only does this leave the machine's own memory free, but it is also a safer medium to be handled by young children than disks or cassettes.

6. HARDWARE

6.1 Computers

We must accept that Logo will enter schools via micro-computers. Three versions of Logo are currently available for two makes of micro-computers. The older versions of these computers need expanded memories before they can cope with Logo.

The graphic part of Logo is available for at least three machines. It is generally expected that these, and possibly other microcomputers, will have special Logo ROM packs available soon.

6.2 Turtles and Other Robot Devices

Turtles which receive instructions from a micro-computer either by radio or through a cable, are now available in S.A. The price (approx R1 000,00) is rather high but is likely to come down.

There are a number of programmable robot toys on the market which accept Logo-like instructions. One of these "Big Trak", costs approx R70, and is used with several experimental groups overseas.

7. LOGO IN TEACHING

Although Logo has been used at pre-graduate university level, it finds application mainly in schools and mainly for the 7 to 16 age group.

7.1 Unstructured Use

Almost without exception Logo is made available to pupils on a "here it is - explore it" basis. The pupils are encouraged to find their way into the Logo world through manuals and under the guidance of teachers whose qualifications vary from mere enthusiasm to rudimentary training in the use of Logo to years of experience with the language.

7.2 Structured use

Although there have been reports in the computer press about schools/research facilities which have developed structured Logo tasks, these reports seem to be premature announcements. Logo task sheets are under development at several centres, but those that were contacted claimed that they were only starting the development now. In South Africa only one school seems to be developing Logo tasks at present.

Some versions of Logo can supply the basis for learning experiences in areas such as music, biology and physics.

7.3 Suggested approach

Schools with suitable computer facilities could perhaps consider the following sequence for introducing Logo.

* Body instructions (Sub A - Std 2)
* Big Trac or other robot device (Sub B - Std 4)
* Physical Turtle (Sub B - Std 4)
* Screen Turtle (Std 1 - Std 5)
* Abstract programming (Stds 4-5).

If sufficient computers are available one may skip the non-computer stages in introducing LOGO. This can be done because the basic commands in turtle graphics have simple, visible effects.

8 RESEARCH RESULTS

Unfortunately most Logo research seems to be phenomological rather than empirical. This is not surprising considering the newness of the field.

Teachers using Logo report opinions such as:

* Greater interest in mathematical concepts
* Motivated to manipulate numbers for fun.
* Can discuss mathematical issues
* Can explain their mathematical difficulties.

One of the few published results of empirical studies come from the Edinburgh Logo Project (Howe, O'Shea and Plane, Teaching Mathematics through Logo Programming D.A.I. research paper No. 115, 1979). The experiment used a group of 11 sixth-grade boys from the lowest-level maths group. After two years the test group scored slightly better than the control group on a "basic mathematics" test, but slightly worse on a "mathematics attainment" test.

The results of the Brookline Logo project were just as inconclusive, even though the staff used tests they had designed to test what they thought they were teaching.

Before one writes off Logo as an aid in the teaching of mathematics, two facts are perhaps relevant:

* The test did not measure attitude towards mathematics
* The tests may have been done with pupils who had very stimulating mathematics programmes in their schools anyway. Logo as an additional stimulus in a very traditional mathematics programme might give different results. It will be interesting to have the results from at least one South African school available at the end of 1983.

Logo though gives us exciting prospects in achieving computer literacy. Molly Watt (1982, p.112) lists the following under the subtitle "What Logo teachers say they teach".

* Computer literacy
* The history and learning theory in Logo
* How to program a computer-like character, a turtle or a Big Trak
* Controlling a turtle on screen
* How to pace out shapes and then teach the turtle to draw shapes
* How to change pen colours and background colours
* How to edit
* How to initialise a disk
* How to draw initials
* How to use "repeat"
* How to use subprocedures in a procedure
* How to use recursion
* How to read a printout or programs (procedures)
* How to draw a procedure tree (structure diagram)
* How to use variables
* How to use the Logo manual
* How to manage files and clear the work place
* How to use existing interactive programs and modify them.

One could perhaps add:

* Structured thinking processes
* Problem solving

Indeed when asked by Molly Watt "What do you learn from Logo?" students replied:

* About problem solving and estimation
* About thinking and learning styles
* About how to use their own learning style
* To think logically
* To work without emotional manipulations: the computer doesn't care whether you feel angry
* To use procedural thinking
* To use strategies for problem solving
* To become comfortable thinking mathematically
* To be able to think geometrically
* To be able to consider laws of motion
* About language by creating my own system for naming procedures
* About graphic design
* How important revision of procedures and text is and how easy it is to do
* That decimals are useful
* How to type
* How to be patient
* How to take risks in working.

The most significant things they claim to have learned include:

* Looking at their own mistakes with an interest in understanding what happened instead of shame
* Feeling competent in setting their own problems and supported in solving them
* Understanding that learning and doing involve frustration and ease: they go quickly or slowly, parts are intriguing or boring, and this is what makes up all work and life.

9. CONCLUSION

1) Logo is a useful vehicle to introduce computer literacy to all.

2) Logo's Turtle Geometry is exceptionally well suited to the requirements of the young learner

3) Logo is a good introductory language, having many of the features of high level languages

4) Logo may be a worthwhile language to learn in its own right.

5) Logo is likely to influence attitudes towards mathematics positively.

6) At present there is no conclusive evidence that Logo significantly improves mathematical skills as measured traditionally.

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See Section 4

LOGO FEATURES FOUND IN OTHER LANGUAGES

	Apl	Basic	C	FORTH	For-tran	LISP	LOGO	Pas-cal
Procedural	✓		✓	✓	✓	✓	✓	✓
Interactive	✓	✓		✓		✓	✓	
Recursive	✓		✓			✓	✓	✓
Iteration	✓	✓			✓		✓	✓
Unrestricted List Processing							✓	
Lists Un-typed						✓	✓	
Extensible	✓				✓	✓	✓	
Designed for Concrete Apl.							✓	
Designed for Beginners	✓						✓	

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