

THE ROLE OF THE MICROCOMPUTER AS A DIAGNOSTIC,
PRESCRIPTIVE AND LEARNING INSTRUMENT IN
REMEDIAL EDUCATION

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It is certainly evident, at this point in time, that the question of whether computers and the related technology will be used in education and/or instruction is no longer relevant. A look at the extent and variety of current educational uses of the computer quickly dispel the notion that their usage is something that might occur in the distant future. They are a fact now! The relevant question today is not whether they will be used to help solve instructional and communication problems of the handicapped but rather how they will be used and how they will affect the education of the handicapped in the next decade.

(Watson, 1979:670)

ABSTRACT

The number of pupils with learning disabilities is on the increase and effective ways of attempting to remediate such pupils are always being sought.

Current technology has presented remedial teachers with a potentially dynamic aid in the form of the microcomputer. Many of the attributes of computer-aided learning closely parallel the principles of remedial teaching and to this end it was attempted to establish the role of the microcomputer in remedial education.

An in-depth study of the literature was undertaken. In the practical sphere, a survey was conducted to obtain the views of practising remedial teachers as well as to establish the extent of applications in schools. Learning disabled pupils were observed interacting with microcomputers.

The study revealed that the prognosis for embracing microcomputers in remedial education is encouraging. Applications exist for diagnosis and prescription of specific deficits as well as for prescribing the microcomputer in the sphere of general educational development of learning disabled pupils.

Further applications for administrative and management purposes have reached an advanced stage of development.

With the development of appropriate software and proper "teacher education" the microcomputer has the potential to become a dynamic educational aid for the learning disabled; especially because of its motivational and user-friendly nature.

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DECLARATION

I declare that this dissertation is my own, unaided work.
It is being submitted for the degree of Master of Education
in the University of Cape Town. It has not been submitted
before for any degree or examination in any other University.

Stuart Ivan Robinson

25th day of November 1985

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STATEMENT OF THE PROBLEM

Pupils with specific learning disabilities* constitute a relatively recent addition to Special Education.

Statistics (Algozzine and Korinek, 1985) suggest that pupils who fall into the category of specifically learning disabled are on the increase. As many of these pupils are to be found in the mainstream classroom, the possibility exists that they might be diagnosed as learning disabled but later be ignored owing to lack of time and ability of the regular classroom teacher to give them the attention that they need.

In 1981 a law - The 1981 Education Act (Special Education Needs) was passed in the United Kingdom. This law required local education authorities to identify and assess pupils in its area who might require special educational assistance. The authorities were required to maintain for each pupil identified, a record of the pupil's needs. This had to be reviewed and maintained on a regular basis.

In the United States a similar law had been passed in 1975. This law was known as Public Law 94 - 142, the Education For All Handicapped Children Act. This law (described elsewhere in this study) specified provisions similar to those of the United Kingdom law.

Incorporated in these laws passed were decisions to integrate special with mainstream education.

* Within the framework of this study the term learning disabled refers to what is known in South Africa as the "remedial pupil". Education of the specifically learning disabled means the remedial pupil in mainstream education. This study does not cover such areas as speech impairment, mental retardation, emotionally disturbed, deaf, hard of hearing, visually handicapped and physically disabled.

In 1981 the Human Sciences Research Council in the Republic of South Africa (HSRC) undertook an in-depth investigation into all aspects of education in the country. The investigation identified particular shortcomings that were to be found in the provision of education for pupils with special educational needs.

Problems such as the following were cited:

.... a general conclusion that can be drawn in respect of *White* children (alone) under the control of the four provincial education departments is that a fairly small percentage of white pupils with the available teachers and facilities are at present receiving remedial assistance in one form or another.... (and) there is a shortage of funds and facilities and.... the demand for remedial assistance cannot be properly satisfied.

(HSRC, 1981:132)

In respect of mainstream education the investigation stated that the class teacher was not in a position to render assistance to a learning disabled pupil on an individual basis for reasons which included the following:

...she is not properly trained to identify, evaluate and assist pupils

...she cannot individualize in her daily teaching because the classes are too big and the syllabuses are overloaded and because the very nature of her training does not permit this.

(HSRC, 1981:142)

Further problem areas identified by the investigation pointed out:

...There is also an urgent need for many more full-time remedial classes to be given for Black and Coloured pupils.

...Educationists find it impossible to pay the necessary attention to compiling auxiliary programmes, holding consultations with and providing the necessary guidance for remedial teachers and class teachers.

(HSRC, 1981:143)

The investigation suggested that the learning disabled child requires assistance at two levels. First he/she needs to be prepared for learning and secondly he/she requires remedial assistance. The latter concerns the designing of remedial reading and mathematic programmes in particular.

In making its recommendation the investigation highlighted the problem of dealing with the learning disabled pupil within mainstream education.

... In this area there are large scale shortcomings in the identification of scholastically impaired pupils, the availability of teachers who can provide remedial assistance, making time for providing assistance of this kind, the diagnosis of children with learning problems and designing remedial programmes for them.

(HSRC, 1981:174)

Although many of the recommendations of the Investigation have not been accepted by the government and despite the fact that no law has been passed in respect of the provision of education for pupils with special needs in South Africa, the problems in the U.S.A., U.K. and also the R.S.A. have certain similarities.

A few of these can be enumerated as follows:

- Lack of trained staff to identify, diagnose and prescribe
- Lack of time to cope with individual needs of pupils requiring IEP's (Individual Education Programmes).

- Lack of resources required e.g. visual, audio-visual, and remedial aids, games, etc.
- Additional burden of administration accompanying requirement of the laws and recommendations e.g. monitoring progress, keeping records etc.

In the United States and the United Kingdom the introduction of legislation in respect of learning disabled pupils has induced educationists to look to technological advances to alleviate the problem. The utilization of the microcomputer has emerged as a means of meeting the needs of the new demands. This dissertation addresses itself to the aforementioned considerations and intends to examine, in the light of current educational technological advances how the microcomputer might be harnessed in an attempt to overcome the impasse that currently exists in coping with the teaching demands of learning disabled pupils.

OBJECTIVE OF THE STUDY

In recent years there have been developments in the sphere of educational technology that have had a significant impact on the educational process. Developments in special education have highlighted the need to re-examine the approach to teaching pupils who fall into this category.

Society has become more complex and the concomitant outcome of this is that changes have come about in the educational sphere. Educational provisions have undergone change and improvement in order to cope with the new demands of a more complex society. As pointed out, special education has not escaped these changes. The literature suggests that a far reaching change in the philosophical approach to learning disabilities has taken place world wide. There seems to be a much broader approach to this category of education and attention now seems to be directed to the "special educational needs" of pupils rather than their specific deficits alone. If this is so, then a new teaching approach is required where specific deficits, alone, are not concentrated upon but where a wider sphere of learning is addressed. Here we

are looking at teaching aids which will also assist with general development. We need to expose learning disabled pupils to instruments which can be used to construct models or representations of the real world thereby presenting them with the opportunity of interacting with the real world. Modern technology in the form of the microcomputer might be able to do just that.

Having pointed out that educationists have looked to the microcomputer as a way of utilising modern technology to assist in the education process, this study will focus on attempting to answer the following question:

On the basis of previous knowledge and research together with current trends and developments, is there a role for the microcomputer as diagnostic, prescriptive and learning instrument in remedial education?

The study will attempt to point out how the microcomputer can be used to prescribe remedies in areas of specific deficits as well as being used in a wider sphere of assisting learning disabled pupils in their general educational development.

Computer technology has changed rapidly and drastically in recent years. The advent of the microcomputer has provided the impetus for the widespread application of the computer in the educational process. Many people have labelled this application a "revolution" or "a major innovation", whilst others say it is simply another "fad".

As soon as the "revolution" took off, researchers and educationists indulged in a flurry of "activity" in the field of microcomputers. The "activity" fell into two general categories: Research to "prove" the justification for, and the effectiveness of the computer in education, and research into all aspects concerning the optimal use of the computer in education. (Serfontein, 1982).

The first category has been studied intensively during the past two decades. At the beginning of the 1980's, Gerald T. Gleason in the United States observed on-going research activities relating to computer use, at various institutions. In respect of the first category of research mentioned above he concluded,

....few serious researchers are now interested in comparative studies, i.e. studies which attempt to compare the results of computer assisted instruction with the results of other strategies, either unique or 'conventional'. The futility, or perhaps fallacy of comparative studies lies in the extreme difficulty of controlling the large number of significant variables which interact in most instructional settings. (Gleason 1981:27)

Acknowledging the above point made by Gleason, this study will focus on the second point made by Serfontein and its objective will be, then, and attempt to examine areas where the microcomputer has and can be used optimally to meet the "special educational needs" of learning disabled pupils in the wider sphere as well as in specific areas of deficit.

PLAN OF THE STUDY

Before examining possible applications of microcomputer technology in remedial education various aspects of these two concepts will be highlighted and defined in order to place the rest of the study in perspective. Following this will be an overview of developments and trends in microcomputer applications with special reference to remedial education. Various learning theories will then be discussed as they relate to computer aided learning. This course will be taken as many theorists cite the application of reinforcement learning principles as the theoretical base for current computer aided learning strategies.

As advances have been made in the application of microcomputers in education, special educationists have perceived the possibilities for

harnessing them in the teaching of the learning disabled. A number of significant studies have been undertaken in an attempt to establish the effectiveness of computer-based remedial techniques over conventional techniques. These studies are discussed as they have formed the basis for the expansion of microcomputer applications in the teaching of the learning disabled.

The expansion of microcomputer applications in teaching learning disabled pupils is further illustrated by discussing observations made of pupils interacting with specifically designed programmes for use with such pupils.

The study concludes with a survey of microcomputer use with learning disabled pupils in South Africa, in general, and the Cape Peninsula (R.S.A.) in particular.

METHOD OF INVESTIGATION

As indicated earlier, the purpose of this study is not an attempt to prove the ascendancy of computer aided learning over conventional modes or vice versa, but rather to examine ways of utilising the microcomputer optimally in the remedial teaching process.

To this end it was accepted that a comprehensive literature study would be necessary as well as the observation of "remedial" microcomputer applications. The idea was to synthesize many studies, views, opinions and expositions of types of microcomputer applications in order to formulate an answer to the research questions posed earlier.

The majority of the data was obtained from a comprehensive literature study. Sources referred to here were the many past and current references dealing with the subject under examination. Much of the data was acquired locally, but a number of current specialized studies were obtained from the Council for Exceptional Children in the United States of America and various Special Education resource units in the United Kingdom. Numerous journals were a valuable source of current research studies. Those which provided a bulk of the data were the Harvard Educational Review, Exceptional Children, Educational Technology, the Journal of Programmed Learning and Educational Technology, and the Journal of Learning Disabilities. Contact with the Council of Educational Technology in the United Kingdom provided a current, well informed source of information in respect of the Microelectronics Educational Programme, whilst the S.R.A. Technologies research papers obtained from the United States provided invaluable data regarding microcomputer use in remedial education there. Personal correspondence with individuals in both the United Kingdom and the United States provided invaluable information regarding sources as well as access to conference papers. In the local context data was derived from surveying individuals working in the field of remedial teaching as well as corresponding, interviewing and consulting with similar individuals. Visits to schools to observe pupils interacting with microcomputers provided a further invaluable insight into work being done in this sphere.

Note: In the course of the study certain abbreviations might be used. LD refers to the term Learning disability. CAI means computer aided instruction, whilst CAL refers to Computer aided learning. These terms are often regarded as synonymous. Other computer related terminology can be found in the glossary.

CHAPTER ONE

1.0 SOME ASPECTS DEFINED

1.1 The Definition of Learning Disabilities

The term learning disabilities was first introduced in 1963 when a group of concerned parents and educators met in Chicago, U.S.A. to consider organizing a cohesive entity from several separate and isolated parent groups that had been formed throughout the country. (Lerner, 1981). The term learning disabilities became acceptable to the various individuals and organizations working in this field, but gave rise to problems when it came to defining the term. The intermingling of many professions brought a multidisciplinary breadth to the field, but it also introduced a confusion of terminology and ideas to the definition. In attempting to identify the population of pupils with learning disabilities, a number of dimensions can be considered. Lerner (1981) discusses various approaches to the problem of definition.

(a) Neurological Dysfunction

Definitions that focus on this dimension of the problem attempt to identify organic aetiology. Cruikshank (1967) believes that specific neurological conditions give rise to learning dysfunction and refers to such children as 'brain-injured', whilst Johnson and Myklebust's (1967) concept of learning disability implies a neurological dysfunction:

....we refer to children as having a psychoneurological learning disability, meaning that behavior has been disturbed as a result of a dysfunction of the brain and that the problem is one of altered processes, not of a generalized incapacity to learn (Johnson and Myklebust, 1967:8)

(b) Uneven Growth Patterns

Emphasis has also been placed on the irregular development of mental abilities in the identification of the learning disability population. An examination of profiles of subskills reveals that growth in the various areas is uneven and inconsistent. Myers and Hamill (1969) refer to this pattern as the "principle of disparity". Gallagher (1966) focuses on such developmental imbalances in identifying the population:

Children with developmental imbalances are those who reveal a developmental disparity in psychological processes related to education of such a degree (often four years or more) as to require the instructional programming of developmental tasks appropriate to the nature and level of the deviant developmental process. (Gallagher, 1966:28)

(c) Difficulty in Academic and Learning Tasks

Kirk (1962) states that in identifying the population of pupils with learning disabilities, the learning problems that children encounter should be considered.

A learning disability refers to a retardation, disorder or delayed development in one or more of the processes of speech, language, reading, spelling, writing, or arithmetic resulting from a possible cerebral dysfunction and/or emotional or behavioural disturbance and not from mental retardation, sensory deprivation or cultural or instructional factors. (Kirk, 1962:28)

(d) Discrepancy between Achievement and Potentiality

A further focus in defining the population of learning disabled pupils is the criterion of a significant discrepancy between what the child is potentially capable of learning and what in fact has been learned. Bateman (1965) defines children with specific learning disabilities as those who

manifest an educationally significant discrepancy between their estimated intellectual potential and actual level of performance related to basic

disorders in the learning processes, which may or may not be accompanied by demonstrable central nervous system dysfunction, and which are not secondary to generalized mental retardation, educational or cultural deprivation, severe emotional disturbance or sensory loss.

(Bateman, 1965:263)

(e) Definition by Exclusion

An added dimension of many of the definitions is that the pupils under consideration do not primarily fit into any other area of exceptionality; that is, pupils with learning disabilities are not primarily mentally retarded, emotionally disturbed, culturally deprived, sensorily handicapped. This dimension, among several others, is included in the definition by Johnson and Myklebust, (1967):

In those having a psychoneurological learning disability, it is the fact of adequate motor ability, average to high intelligence, adequate hearing and vision, and adequate emotional adjustment together with a deficiency in learning that constitutes the basis for homogeneity. (Johnson & Myklebust, 1967:9)

In the United States of America, attempts to formulate a definition of learning disabilities has continued since the inception of the field. The most widely accepted definition is that which is part of U.S. Public Law 94-142, the Education for All Handicapped Children Act. This definition has become the basis for Federal and State law in the United States, as well as many learning disabilities programmes, both in the United States and abroad. (Lerner, 1981)

There are two parts to the Federal definition. The first part appears in the major body of the rules and regulations of PL 94-142 and was adopted from a report of the National Advisory Committee on Handicapped Children (1968) to the United States Congress. The definition is as follows:

'Specific learning disability' means a disorder in one or more of the basic psychological processes involved in understanding or in using language spoken or written, which may manifest itself in an imperfect ability to listen, think, speak, read, write, spell,

or to do mathematical calculations. The term includes such conditions as perceptual handicaps, brain injury, minimal brain dysfunction, dyslexia, developmental aphasia. The term does not include children who have learning problems which are primarily the result of visual, hearing, or motor handicaps, of mental retardation, of emotional disturbance, or of environmental, cultural, or economic disadvantage.

The second part of the Federal definition is considered an operational definition. It appears in a separate set of regulations applying to PL 94-142, which are concerned solely with specific learning disabilities. These regulations resulted from considerable debate and discussion on the part of the profession and are designed to give procedures for evaluating specific learning disabilities. They specify that a team may determine that a pupil has a learning disability if:

- (a) The child does not achieve commensurate with his or her age and ability levels in one or more of seven specific areas when provided with learning experiences appropriate for the child's age and ability levels
- (b) The team finds that a child has a severe discrepancy between achievement and intellectual ability in one or more of the following areas:
 - Oral expression
 - Listening comprehension
 - Written expression
 - Basic reading skill
 - Reading comprehension
 - Mathematics calculation
 - Mathematics reasoning

(Lerner, 1981:7)

Hallahan and Kauffman (1976) point out that, while certain organizations and individuals, who have entered the debate, may differ with regard to subtle nuances of the definition of learning disabilities, five major points are almost universally present in any definition. The learning disabled pupil: (a) has academic retardation, (b) an uneven pattern of development, (c) may or may not have central nervous system dysfunctioning, (d) does not owe his learning problems to environmental disadvantages, and (e) does not owe his learning problems to mental retardation or emotional disturbance. (Hallahan and Kauffman, 1976)

1.2 Prevalence of Learning Disabilities

A number of estimates of the prevalence of pupils who suffer from learning disabilities has been made, ranging from 1% - 50% of the school population, depending on the criteria used to determine the disability. (Lerner 1981, Westwood 1981, H S R C 1980) In the United States one estimate for example was the result of a screening of almost three thousand pupils in the third and fourth grades in a public school population; this screening was conducted as part of a research project at Northwestern University. (Myklebust and Boshes, 1969). The identification criterion used in this study was based on an education-discrepancy definition of learning disabilities. The entire public school population was initially screened by administering a battery of psychoeducational tests and deriving a ratio between achievement and expectancy for each pupil tested. The criteria of underachievement was a ratio or learning quotient of less than 80; by this standard, 15% of the research population were identified as underachievers. However, further study and more stringent criteria for identification revealed that one half of those initially identified fell into the category of learning disabled. In this study, then, the prevalence of children with learning disabilities in the school population examined was determined to be 7 - 8%.

A more conservative estimate was made by National Advisory Committee on handicapped pupils in the United States. They recommended that 1 - 3% of the school population be considered as a prevalence estimate; at least until research provides objective criteria for identifying these children more clearly.

Westwood (1981) points out that the number of pupils in the United Kingdom who can be categorized as learning disabled is not small. He states:

We are faced with the probability that at least 13% to 16% of pupils in 'average' infant schools require some form of special help for some part of their early primary schooling. In some depressed areas, particularly the urban slums and

over-spill estates where the child is known to be 'educationally at risk' the figure 16% is a gross underestimation of the extent of the need. Failure to provide adequate special help at primary level undoubtedly goes a long way towards explaining the fact that, at secondary school level, it is not at all uncommon to find more than 20% of the pupils needing special educational help. (Westwood, 1981:1)

As this dissertation will also focus on learning disabilities in the Republic of South Africa in general, and the Cape Peninsula in particular, it is appropriate to consider the incidence of learning disabilities in the Republic of South Africa.

In the early 70's the South African Government realized the need to develop the potential of each individual as far as possible to the full. This was owing to the increased need for skilled manpower in the Republic. (CPA, 1971)

In order to utilize the labour potential of the population to the full, various committees were appointed by the government to investigate the phenomenon of learning disabilities to produce data which would be scientifically founded and to make the necessary recommendations to cope with the problem. According to the Report of the Committee of Inquiry into the Education of Children with Minimal Brain Dysfunction, it was found that approximately 15% of pupils with normal intelligence did not progress according to their ability. This percentage did not include pupils who were mentally retarded. The 15% thus suffered from disabilities which were not attributable to low intelligence. (CPA, 1971)

In June 1980, the South African Government Cabinet requested the Human Sciences Research Council (HSRC) to conduct an in-depth investigation into all facets of education in the R.S.A. The investigation consisted of a number of work committees which investigated various aspects of the educational structure in the R.S.A. One such work committee was the Work Committee : Education for Children with Special Educational Needs.

The educational system in South Africa is complex with numerous educational authorities controlling education on provincial and racial lines. The result of this divided control is that matters such as planning and policy-making differ, which means that programmes for identification and rendering assistance to children with special educational needs are approached in different ways. Co-ordination does exist but even between the provincial authorities there are still differences when it comes to defining the criteria for recognition and identification procedures for children with special educational needs.

Because of the difference in policy in respect of the particular education authorities, provision of education and the number of pupils identified as children with special educational needs differs from one education authority to the next.

Very briefly below, data is enumerated in respect of learning disabilities as they relate to the various departments in the R.S.A. (HSRC, 1981)

(a) Department of Education, Cape of Good Hope (White)

Data provided by this department indicates that in 1980 about 0,7% of the total primary and secondary school population received remedial assistance from trained remedial teachers on a separate session basis.

(b) The Education Department of the Orange Free State (White)

In 1980 0,07% of the total primary school population received remedial assistance in separate classes.

(c) The Natal Education Department (White)

In 1980 3,4% of the total school population received remedial education from full-time remedial teaching staff after the children had been identified by the class teacher.

(d) Transvaal Education Department (White)

About 6,79% of the total school population (primary and secondary) in the Transvaal receives one or other form of remedial assistance.

(e) Department of Internal Affairs (Indian)

In 1980 there were approximately 1 670 pupils (0,77% of the total school population) who received remedial assistance in the course of remedial sessions outside the class context.

(f) Department of Internal Affairs (Coloured)

In 1980 remedial education in this department was still in an early stage of development and remedial lessons were given at primary schools on a session basis. Remedial sessions were also presented at school clinics with a view to finer diagnosis and more specialized treatment of problem cases. About 250 pupils could be assisted in this way in a specific period of time.

(g) Department of Education and Training (Black)

Data on the number of pupils who receive remedial assistance was not available. For a number of reasons - particularly owing to large classes - one can possibly assume that a large percentage of pupils in every class can probably be labelled as scholastically impaired. The figure of 50% of scholastically impaired pupils is sometimes given, but this is not at all reliable.

Hallahan and Kauffman (1976) point out that within all areas of special education, it is generally quite difficult to arrive at accurate prevalence estimates. Different sources come to different conclusions regarding the incidence of various categories of exceptional pupils. The single greatest problem in determining how many pupils or what proportion of pupils, might have a particular behavioural exceptionality revolves around the difficulty involved in finding a common definition that everyone can agree to. The greater the amount of disagreement as to what constitutes a particular area of exceptionality the more varied will be the estimates of the numbers of pupils in that category. Because of the inordinate amount of confusion with regard to the criteria used to classify pupils as learning disabled, the prevalence estimates are the most diverse of all the categories of special education.

Algozzine and Korinek (1985) endorse this view. They state that the number of handicapped pupils counted at any given time is referred to as a prevalence estimate. The word estimate is used because pupils enter and leave programmes every day and there is no way of knowing exactly how many are being served at any one time. During the period 1978-1982 an analysis of handicapped pupils was carried out in the United States by Bob Algozzine and Lori Korinek. Data was collected from 50 States. In the investigation, a distinction was made between low and high prevalence handicaps. Low prevalence categories included pupils classified as Other Health Impaired (OHI), Orthopaedically Impaired (OI), Deaf and Hard of Hearing (DHH), Visually Handicapped (VH), Multihandicapped (MH) and Deaf and Blind (DB). Categories referred to as high prevalence handicaps, categorized according to definitions and eligibility criteria based primarily on psychometric results (e.g. IQ scores, achievement test scores, behaviour ratings) included the Speech Impaired (SI), Learning Disabled (LD), Mentally Retarded (MR) and Emotionally Disturbed (ED). Results of the investigation showed that more than 90% of the pupils were classified in the four high prevalence handicapped conditions. (Algozzine and Korinek, 1985)

What is interesting to note is that pupils classified by definition as learning disabled increased at a rate of \pm 3% per year, (Table 1), whilst most other categories showed a decrease.

Table 1 : Average Percentage of Pupils Served During
5-year Time Period

Category	SCHOOL YEAR				
	1978	1979	1980	1981	1982
Speech Impaired	30,54	29,10	28,03	27,12	26,40
Learning Disabled	28,77	32,49	35,60	38,16	40,40
Mentally Retarded	25,93	23,34	21,57	19,73	18,47
Emotionally Disturbed	6,85	7,55	7,38	7,63	7,68
Other Health Impaired	2,95	1,75	1,67	1,51	1,34
Orthopaedically Impaired	1,88	1,45	1,40	1,34	1,35
Deaf and Hard of Hearing	2,27	2,18	2,03	1,99	1,89
Visually Handicapped	0,96	0,82	0,78	0,75	0,72
Multihandicapped	- *	1,47	1,71	1,82	1,88
Deaf-Blind	- *	0,07	0,08	0,09	0,10
*Data were not reported during School year					

(Algozzine and Korinek, 1985:389)

Questions have been raised in respect of findings in the investigation. In the 1984 United States Department of Education report to Congress it was stated:

Reasons for this rapid growth in the number of children served as learning disabled include improved assessment procedures, liberal eligibility criteria, social acceptability for the learning disabled classification, and a lack of general education alternatives for children who experience problems in regular classes. (USDE, 1984:5)

Algozzine and Korinek (1985) state that special education prevalence figures are influenced by a complex set of interacting factors evident in the professional literature, but suggest that there is ample evidence to suggest that learning disabilities are easier to find today than

several years ago and that this is largely due to changes in underlying concepts, definitions and diagnostic strategies.

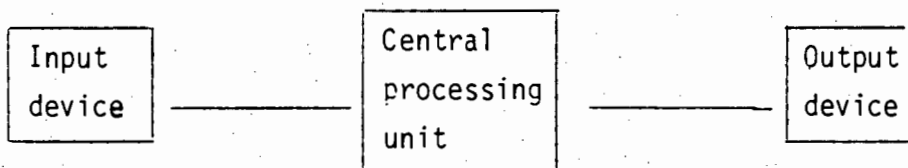
Hallahan and Kauffman (1976) have a point, therefore, when they suggest that the problem still rests with the interpretation of the definition and the fact that many professionals are thus still undecided regarding how many pupils should be identified as learning disabled.

It should be kept in mind that the most accepted estimates are based on a definition of learning disabilities that excludes pupils who would also be classified as emotionally disturbed, educable mentally retarded, or economically disadvantaged. Without these exclusion clauses the prevalence estimates might be higher.

1.3 What is a Microcomputer?

A microcomputer, like any other computer, is a device which enables signals to be manipulated and changed. The computer has the potential to evaluate what is going on and, if it has the appropriate information, makes decisions about what action to take.

A simple model of a microcomputer can be shown as follows:



As indicated above, there are three main parts to a microcomputer.

- (a) The input device which allows one to enter either instructions or data into the microcomputer.
- (b) The Central processing unit (CPU) which amongst other things, carries out the instructions that have been keyed in. This processing results in a modification of the data giving the 'answer' or output that is required.
- (c) An output device enables one to receive the result of the processing.

The main elements of the microcomputer just discussed are illustrated below. (Fig. 1)

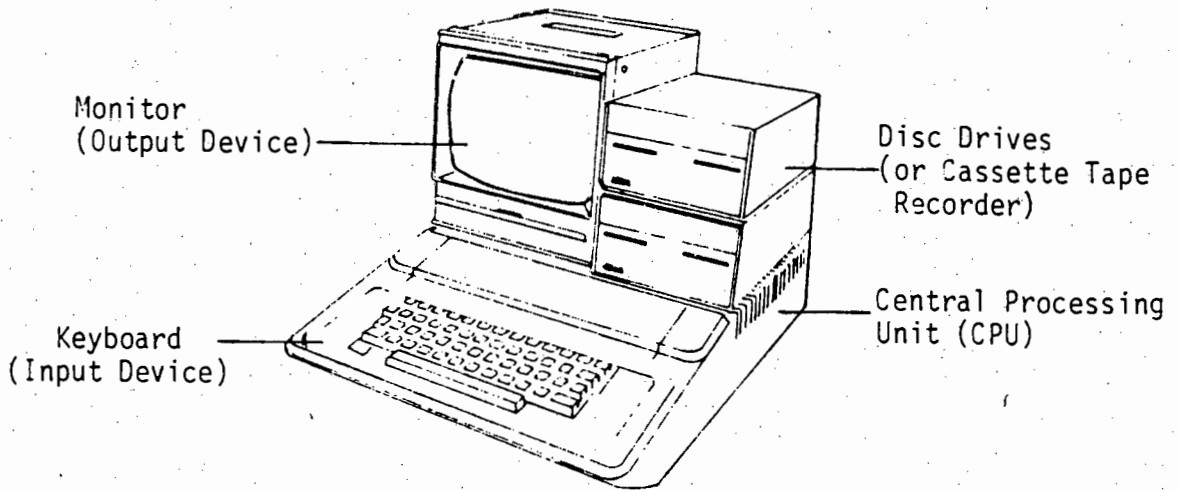


Fig. 1 Main Elements of a Microcomputer

Self-manufactured or commercially acquired programmes can be run on the microcomputer via a disc drive or a cassette tape recorder. What actually happens when a programme is begun is that the machine starts from a specific instruction. This is achieved by pressing several control keys. The machine continues by running through the programme instruction by instruction. It is important that when the programme is complete, a STOP/END is included in the programme at this point otherwise chaos will ensue. This problem highlights the fact that unless told, the microcomputer by itself does not know whether a location contains data or an instruction. It is the structure and organization of the programme itself which determines what are commands and what are data. Included in the programme can be certain instructions which enable other instructions to be left out or missed if certain conditions are satisfied, so that programmes do not generally

proceed from location to location in strict rotation. It can be perceived, therefore, that a microcomputer with its associated programme is potentially a very powerful learning device. The major advantage of the microcomputer lies in the way in which it can be programmed to produce an unlimited variety of situations to help provide learning environments appropriate to the needs of many different groups of people. For further information on the functioning of microcomputers, a useful source to refer to is Microcomputers in Special Education by Florence M Taber (1984).

1.4 The Roles of the Classroom and Remedial Teacher in the Remedial Teaching Situation

In order to perceive the way in which the classroom or remedial teachers can possibly harness the use of microcomputers in the diagnostic and prescriptive process, it will be necessary to examine their roles in the remedial teaching situation.

In the South African context, the classroom teacher in general is expected to render specific assistance (in the context of the class in mainstream education) to a pupil who displays a learning disability. This scholastic problem may be in the broad spectrum of the pupil's learning activities or a specific section of the subject matter. A pupil who makes himself conspicuous because of a sustained need for extra or special assistance is eventually referred to a remedial teacher after a certain course has been followed.

This can be described as follows. The pupil is identified as having a "learning problem". The classroom teacher attempts to render assistance. If this is not successful, the teacher reports to the principal who then reports to the School Psychological services. The pupil is evaluated and recommendations are made in respect of a strategy. The strategy or programme is then implemented.

The classroom teacher is included in the remedial programme and works in conjunction with the remedial teacher. In a number of cases the

prescription might be beyond the scope of the classroom teacher. The pupil then attends private sessions with the resident or itinerant remedial teacher about twice or three times a week, where specific remediation is administered in areas of deficit.

In a number of schools, especially in the Cape Peninsula, it has been departmental policy for a number of years now to implement the so-called T.A.T. programme. The T.A.T. or Teacher Assistant Team strategy has by all accounts worked well. It is designed to take the load off the remedial teacher and involve the classroom teacher as much as possible in the remediation programme where "specialized" knowledge is not required.

The resident remedial teacher acts as a consultant to the team and assists with diagnosis if necessary, and provides guidance in respect of prescription or programme design where required.

The two areas above have focused mainly on the role of the classroom teacher. In areas where the pupil is diagnosed as having problems which need to be dealt with, and which are beyond the scope of the classroom teacher, the pupil is often referred to the resident remedial teacher for specific assistance. This might also include such areas as sensory, perceptual or motor deficits where specialized knowledge is required in administering the programme. The pupil is removed for the session and attends a lesson (one-to-one) in the remedial teachers' resource room.

An extension of the remedial teacher's function can be enumerated as follows.

- (a) Setting up programmes for identifying, diagnosing and instructing pupils with learning disabilities.
- (b) Finding or screening the pupils within the school who are handicapped by learning disabilities.
- (c) Consulting with professionals from contributing disciplines and interpreting their reports.
- (d) Testing and diagnosing individual pupils.

- (e) Planning prescriptive educational programmes.
- (f) Implementing the designed programmes through teaching and creating or locating appropriate materials and methods.
- (g) Interviewing and consulting with parents.
- (h) Helping the classroom teacher and other school personnel to understand the pupil and providing teachers with ways to help the pupil.
- (i) Helping the pupil to develop self-understanding and to gain the hope and confidence necessary to cope with and start to overcome the handicap.

1.5 The Difference Between CAL and Traditional Modes of Teaching

The most fundamental difference between CAL and traditional teaching is that the pupil is interacting with a mechanical device rather than with another person. The way in which the pupil is going to react or relate to the machine is completely different. In a regular classroom he can become completely passive, never communicating or responding to the teacher. He can simply observe other pupils doing the communicating and responding. In CAL this is not the case. If he is going to interact properly with the microcomputer in order to derive some benefit, he needs to respond to every question. He will do this privately in front of his own microcomputer terminal where he need not feel embarrassed and exposed if he gives an incorrect answer.

In a regular classroom pupils can communicate with the teacher in many ways and be understood. Only highly sophisticated CAL software is capable of this. Implicit in this is the fact that the teacher can understand and accept partially correct answers or correct answers expressed differently to what the teacher expected. CAL software can rarely anticipate such responses.

CAL is an individual activity and is individually paced as opposed to the regular classroom activity which is paced at the average member of

the group. This implies that a pupil can in some cases go back over a section that he does not understand. In a regular classroom communication takes place by looking and speaking. If a pupil does not understand he can ask the teacher to clarify. In CAL the pupil receives the information visibly and in most cases does not hear it. He depends on the clarity of the mode of delivery both visually and in meaning. He usually has to interpret text or graphics first time in order to understand and proceed with the lesson.

In the regular classroom, a teacher can detect whether a pupil is following by observing his behaviour and asking him to respond to questions as the lesson progresses. A microcomputer cannot see a pupil and is therefore unaware of these characteristics. The microcomputer is only aware of a pupil not understanding or being distracted when it is programmed to monitor responses and progress.

In a regular classroom, a pupil responds by speaking or writing in a notebook. With CAL the pupil responds by typing answers via a keyboard.

These differences in the modes of instruction need to be carefully considered by any teacher using CAL materials. This is especially the case with learning disabled pupils. The differences and the concomitant advantages or disadvantages need to be weighed up in the light of the pupils' needs and deficits. They are also important when considering the selection and acquisition of software and even more so when the teacher of learning disabled pupils is considering designing material himself.

CHAPTER TWO

2.0 AN OVERVIEW OF DEVELOPMENTS AND TRENDS IN COMPUTER AIDED LEARNING IN THE UNITED STATES OF AMERICA, UNITED KINGDOM AND THE REPUBLIC OF SOUTH AFRICA

2.1 Introduction

The purpose of this chapter is to outline developments in computer assisted learning in the United States of America and Britain. These two countries have been the Western leaders in the development of this technology and many other countries have taken the lead from progress made there. In the light of developments made in these countries the situation in South Africa will also be examined. As this dissertation is concerned with the education of learning disabled pupils, micro-computer "activity" that has branched in the direction of learning disabilities will be discussed.

2.2 Where Did it all Begin?

The earliest recognizable computers emerged from research laboratories in the late 1940's and now in the 1980's are already in use in a myriad of applications in all spheres of daily life including education. Assisted by repeated advances in electronic technology, they are now spreading even faster.

It will be appropriate to reflect briefly on the roots and development of the microelectronics revolution which has led us to where we are today in respect of microcomputer use in education.

John Maddison (1983) states that in the broadest sense, the deep roots of the new technology can be traced far back into pre-history and to such phenomena as Stonehenge and beyond. Maddison suggests that, more specifically, the story begins on the shores of the Mediterranean in the first millenium B.C. or possibly earlier with what was, after fingers and toes, the first visual aid to Mathematics - the sand table. This tray of sand (abax in Greek) with its grooves for the movable counting units, the pebbles (calcule) was the prototype of the abacus, the

counting frame, invented independently in widely separated countries. The mathematical aspect in the progress of these developments appears and re-appears as advances were made. This can be seen from the invention in India (500-1200 A.D.), of the zero digit essential to modern computational technology, to the work of Clerk-Maxwell, the founder of the electromagnetic theory.

There are two historical figures who stand out when it comes to considering mechanical technique applied to computing. These are Pascal and Leibnitz. Pascal completed in 1645, and later after much experimentation perfected the first adding and subtracting machine. This was known as the 'Pascaline'. Leibnitz was inspired by the work done by Pascal and set to work on a similar invention. In the last decade of the 17th century, he perfected the first prototype of the modern desk top calculator. This machine incorporated a new element - a ratchet - which could add, subtract and multiply by successive additions. The precision mechanics of the day were not sufficiently advanced to enable him to build the machine for division and calculating square and cube roots. Besides brilliant people of the nature of Pascal and Leibnitz, social and economic factors also played a part in the development of this technology. So too have new mechanical inventions and manufacturing techniques. For example, the typewriter from the 1860's has bequeathed its keyboard to the terminals of today's microcomputers.

One of the most outstanding scientific geniuses of the nineteenth century was Charles Babbage. He is considered to be the "father of computing". Besides his many other scientific and educational achievements, he is chiefly remembered as the first man to construct a 'computer' in anything like the sense we use it today. Babbage invented a 'Difference Engine' which embodied a series of registers, each with its own adding mechanism connected to operate on a fixed programme. Babbage later advanced on this device and invented his 'Analytical Engine'. Babbage had concluded - since his previous invention - that efficiency and economy would be achieved by separating the functions of storage and arithmetical calculation. He proposed therefore to give his machine a store (a memory in

effect) and an arithmetic unit - a mill (a calculating and decision-making unit). Owing to a number of reasons, the 'Analytical Engine' was never built. However, Babbage's significance in respect of computer advances today has been concisely evaluated by Lord Bowden in the following terms:

He was an intellectual giant who introduced to the world many of the ideas upon which modern computers depend. I think that in 1840 he had a clearer understanding of the underlying principles of computers than IBM had when they built Harvard Mark I more than a hundred years later. (Maddison, 1983:7)

In the 1940's the first large computers emerged. These devices had a relatively short life, since the electronic techniques they used had originated as long before as 1904 in the work on thermionic valves of Sir Ambrose Fleming and others. These early computers were located in large rooms - indeed, sometimes buildings - which were specially constructed for them. The first large computer built for sale was a version of Manchester University's Mark I. It contained over four thousand valves on racks in air conditioned cabinets. Computers in this form were large, costly, unreliable, and huge consumers of power. They soon became outdated when transistors were invented in 1948. These transistors replaced thermionic valves as active electronic devices for general purposes.

About twenty-five years later came the introduction of microprocessors. This advanced the micro revolution to an even greater extent than had previously been the case.

The enormous growth in the manufacture and availability of devices incorporating the silicon chip put more microcomputers on the market in the 1980's than had previously been the case and amazingly, these microcomputers had a greater capacity than the earlier larger mainframe computers; they were twenty times faster, had a larger memory, were thousands of times more reliable, took up to 30 000 times less space, consumed the power of a light bulb and were 10 000 times cheaper. (Maddison, 1983)

By 1979 more than a quarter of a million electronic components could be placed on a chip the size of a drawing pin head to form microprocessors. In 1980 it became possible to hold a million 'bits' of information on a single chip.

It was at this point that educational authorities and governments realized that they had to respond to the revolution. It had become obvious that the microcomputer could be utilized as a potent educational tool. In the U.S.A., U.K. and R.S.A. the educational authorities - who had investigated programmed learning and computer-aided learning in a rather cursory manner up to this point, embarked on establishing Commissions and Programmes to estimate how to utilize the microcomputer optimally in their educational systems. Commissions and organizations such as The National Association of Users of Computer Aids to Learning (NAUCAL) and SRA Technologies in the United States of America; The National Development Programme in Computer Assisted Learning (NDPCAL) and Microelectronics Education Programme (MEP) in the United Kingdom and the Human Sciences Research Council (H S R C) in the Republic of South Africa, instituted large-scale, on-going investigations into education in general and computer use in education in particular.

It is the purpose of the section following to present an overview of the developments and trends in CAL in these countries in the light of work done by individuals and Commissions in order to establish the extent of the advances made in the 'regular' education sphere, as well as the sphere of education of pupils with specific learning disabilities.

2.3 The United States

2.3.1 General Developments in Computer-Aided Learning

The earliest involvement with computer aided learning in the United States began in the late 1950's and the early 1960's. These early "experiments" were funded mainly by the large computer companies such as IBM, as well as Federal agencies such as the National Science Foundation. Private foundations such as Carnegie as well as Universities also became involved.

Early work with handicapped pupils evolved from the work in 1963 by Patrick Suppes and Richard Atkinson at Stanford University. The early phase of their project was concerned with the development of courseware to be used for drill and practice in mathematics and language arts for elementary school pupils. In the 1960's further developments in CAL took place at universities such as Illinois and California (Irvine); but work here was aimed at university and college students, and encompassed university subjects such as physics and mathematics.

Into the 1980's computer-aided learning in the United States has become a field which is so diverse and rapidly changing that it is almost impossible to point exactly to where developments have progressed at any one time. The National Association of Users of Computer Aids to Learning (NAUCAL) stated that it saw the domain of computer-aided learning to be that of learning about the computer, learning through the computer, learning with the computer and computer learning support systems. (Zinn; In Rushby; Ed., 1981)

In the 1980's microcomputer applications in the United States have tended to focus on the points enumerated above.

James Hassett (1984) states that from 1981 to 1982 the number of schools with computers nearly doubled and that in 1983 more than two out of every three public schools owned at least one computer. According to the most recent count in the United States there are about 92 students per machine in schools that own computers. (Hassett, 1984) Hassett suggests that there can be little doubt that mass marketing has played an important role in the adoption of the new technology but adds that microcomputers are undeniably becoming an important part of the schools' curricula in two broad areas : learning about computers and learning with computers. The trend into the 1980's is for high schools to focus on the first approach, emphasizing both computer science and the elusive concept of computer literacy. According to the John Hopkins University survey carried out by Henry Jay Becker in 1983, high schools are beginning to devote more time to computer programming than to educational games or drills in other subjects. In elementary schools, the opposite

trend seems to be evident, with most schools tending to use the computer as a means to achieve some academic goal in mathematics, English, science or social studies. Most educational software currently available in the United States is aimed at elementary level and uses the computer as a tool to teach traditional subjects. (Hassett, 1984) Much of the software is still poorly designed and software evaluations are performed by the Educational Products Information Exchange Institute (EPIE) based at Teachers College, Columbia University. Very few programmes still seem to meet the minimum technical and instructional standards set by the Institute. Recent (1983) surveys suggest that only about three or four out of every 100 programmes were considered excellent. (Hassett, 1984)

With reference to the question of programming, again, the John Hopkins survey found that 76% of high schools and 47% of the elementary schools that own computers now offer regular or extensive instruction in computer programming. It was shown that schools reported that the amount of time devoted to programming instruction went up each year that they owned a microcomputer, while the time devoted to using the computer to teach other subjects steadily declined. The trend for the present seems that schools apparently have decided that the best educational use of computers is to teach students about computers.

Into the 1980's the relevant authorities in the United States realized the need for computer-aided learning to interact with a number of needs and issues related to technology as well as to educational applications. A major need at a national level was perceived as one where co-ordination was necessary in planning and funding. The authorities realize the need to accomplish direction in respect of goals, standards and credibility. It is suggested by Zinn, (In Rushby, Ed., 1981) that funding necessary to meet the needs in the area of education can no longer be handled piecemeal through many different agencies. The commitment to excellence in education, and to effective use in technology, Zinn states, must come from the top. Information and advice on the educational use of computers in areas such as research development,

elementary and professional education as well as special education (i.e. gifted and handicapped) have accumulated over a number of years in the form of recommendations of commissions and professional organizations.

Currently - and possibly - in response to pressures and problems attention is being given to areas of specialized education and ways are being sought to harness microcomputers for application in these areas.

2.3.2 Developments in Microcomputer Use with Learning Disabled Pupils

During the 1970's State and Federal legislation in the United States placed demands on special education programmes for increased organization, management and provision of educational services. One such piece of legislation was PL 94-142. (The Education for All Handicapped Children Act of 1975). The United States Congress explained its findings in respect of special education in Section 601(b) of its report, but declared its intent in Section 601(c). This intent set the tone for enormous changes in public school programmes to provide full educational services to the handicapped. The section reads:

It is the purpose of this Act to assure that all handicapped children have available to them within the time periods specified..., a free appropriate public education which emphasizes special education and related services designed to meet their unique needs, to assure that the rights of handicapped children and their parents or guardians are protected, to assist States and localities to provide for the education of all handicapped children, and to assess and assure the effectiveness of efforts to educate handicapped children. (Mayer, 1982:93)

The requirements which came about as a result of P.L. 94-142 increased the paperwork and documentation; created greater need for interpersonal communication and co-operation among staff; and put a new emphasis on regular, accountable, individualized instruction and measurement of pupil progress. (Hanley, 1983) In this context, a number of educators started to look to a new technology, namely the microcomputer, to assist

them in accomplishing the tasks associated with the comprehensive delivery of education services to learning disabled pupils.

On the strength of individual research undertaken by people such as Cartwright and Hall (1974), Carmen and Kosberg (1982), and Hasselbring (1982), support grew amongst special educators for the adoption of microcomputers as an aid for children with learning disabilities. Vanderheiden (1982) stated:

It would be impossible to quote an exhaustive list of the special functions microcomputers could provide for disabled individuals. Almost any aspect of human activity that has been impaired could potentially be aided to some degree though the use of microcomputers as processors, manipulators or controllers. (Vanderheiden, 1982:138)

With such attitudes and the interest of special educators in pursuing the possibilities of utilizing microcomputers with learning disabled pupils, a study was sponsored by Special Education Programmes (SEP), U.S. Department of Education, to investigate "Microcomputers in the Schools - Implementation in Special Education". This study was undertaken in 1983 and to the knowledge of the writer this is the only such major government sponsored study undertaken in the United States in respect of microcomputer use with learning disabled pupils. The report on the organizational aspects makes interesting reading. It is intended that the information collected and analyzed in the investigation will serve as a basis for an extensive dissemination effort to assist teachers of learning disabled pupils in using microcomputers appropriately and effectively.

During 1983, case studies were conducted in 12 school districts across the United States in order to investigate organizational issues related to microcomputer use in the education of learning disabled pupils. (Appendix 1). Besides conducting the study with particular characteristics in mind such as geographic dispersion, elementary and secondary programmes implemented, administrative and instructional application of microcomputers and instructional applications with pupils representing a variety of handicapping conditions; two other features were

considered important. These were the following:

- History. In order to measure the process of implementation it was important that the microcomputers had been introduced at least eighteen months prior to the case study investigation. This would enable an examination of a sequence of implementation of steps, including planning, adoption, allocation, management, training and software acquisition.
- Collaboration. An area of particular interest to the investigators was the interaction between teachers of learning disabled and ordinary teachers in the use of the microcomputers at their particular schools.

Aspects which were highlighted for the purpose of the investigation were:

- Characteristics of Microcomputer "Systems"
- Special Education use of microcomputers - Collaboration or Specialization?
- Supervising the microcomputers from the top down, or the bottom up?
- Administrative and Instructional application : Competitive or Complimentary?
- Training and emerging staff roles for microcomputer implementation.

Significant aspects of the above areas of investigation are outlined below.

In respect of the characteristics of microcomputer systems, the investigators defined a microcomputer system in a school district as a set of microcomputers shared by an identifiable group of users. The microcomputers served a variety of purposes and specific applications by users could be relatively independent. The "System", Hanley states, was characterized by the presence of several decision-making patterns:

- (a) Co-ordinated decisions were made in the initial purchase and adoption of microcomputers;
- (b) Co-ordinated decisions were made regarding the allocation of microcomputers to different physical locations, to different applications, or to meet various scheduling needs;
- (c) Some functional interdependency existed among the units - for example, in the formal sharing of software or the provision of maintenance; and
- (d) Some common arrangements were made to provide technical assistance or training to users.

When attempting to assess the role of the microcomputer in special education a key question was asked:

- Does the teaching of learning disabled need its own system of microcomputers, or can learning disability applications be integrated with other microcomputer applications?

The investigators came up with a very clear answer on this issue:

- Many needs of learning disabled pupils could be satisfied within the context of a more general microcomputer system.

Further, on the question of whether teachers of learning disabled pupils should have their own microcomputer system or whether they should collaborate with mainstream education, it was found that some of the most successful uses - in terms of the number of teachers and pupils involved, and the diversity and extent of applications made - occurred in districts where the microcomputers were available to both special and regular education users. Hanley states that in many of the cases cited above, the differences in applications between the two groups were essentially transparent - training for staff was the same and the software and approaches to the microcomputers were identical.

When it came to the question of supervising the microcomputer, it was established that most school systems contained both centralized and

decentralized decision-making patterns. Questions that were raised in respect of this issue were:

- Who is involved in implementing microcomputers and how do their roles affect the acceptance of the technology into the school system? and
- To what degree do features of the technology itself affect the organization and delivery of educational services?

To examine this issue, the investigators documented the supervisory patterns present in the various school districts, including the organizational framework for the special education programme. The investigators examined the staff and activities associated with microcomputer implementations; especially decision-making patterns related to planning, adoption, purchase, allocation, software review and selection, management of the units and training.

It was found that neither a centralized nor a decentralized pattern had clear advantages; growth (numbers of microcomputers and users) and utilization (number and diversity of applications) occurred with similar success in both types of systems.

A number of the schools investigated utilized their computer systems both for instructional and administrative purposes. This gave rise to the debate as to whether or not administrative and instructional applications could be implemented within the same computer system. In order to examine this issue in terms of microcomputer applications, the investigators examined school systems that had implemented administrative, or instructional, or both types of applications. In some cases, the system began with only one type of application, but later expanded to include both types. In the majority of cases, (nine out of twelve), the microcomputers were used initially for instructional applications only, but seven of the systems initially designed for instructional applications only added administrative applications later. It was found that growth of microcomputer systems were strongest in systems where both administrative and instructional applications were

used. To a degree it can be inferred that the introduction of administrative application into an instructional system did not necessarily restrict or inhibit the instructional uses.

In respect of training and emerging roles for teachers of learning disabled pupils with the use of microcomputers, it was established that the various school districts used a variety of approaches to prepare teachers to use microcomputers. This ranged from self-instruction and individualized technical assistance, common in the initial stages of microcomputer adoption, to large-scale, district-wide in-service courses. It was interesting to note that most teachers were not interested in learning how to programme; they simply wanted to be able to use the computers.

As far as teachers of the learning disabled were concerned, the content of the courses offered was no different to the content for teachers in the regular classroom.

When growth occurred beyond the initial adoption of computers, the need for co-ordination of the microcomputer system evolved. Most of the school districts investigated established formal "co-ordinator" functions. The co-ordinator role was that of improving management (of numerous units) and to reduce inefficiencies, redundances and incompatibilities (of equipment) across users.

Hanley (1983) suggests that the application of microcomputers in the teaching of learning disabled pupils will remain partly experimental in nature for the near future and that attention will have to be given to planning, monitoring and evaluating its use in the teaching of these pupils. Ultimately, he suggests, special education administrators may have to take a more active role in the planning and management of microcomputer systems to encourage more specialized use of micro-computer technology in programmes for learning disabled pupils.

2.4 The United Kingdom

2.4.1 General Developments in Computer-Aided Learning

Most of the activity in the United Kingdom in the sphere of CAL is fairly recent. Much of the progress made during the 1970's is based on the work of the National Development Programme.

(NDP, 1973-1977) One cannot, however, overlook the work and support given by the research councils - particularly the Social Science Research Council (SSRC), prior to this date.

Maddison (1983) states that, historically, the introduction of computers into education in Britain began in the universities. Certain universities in England were at the forefront in developing important forms of computer construction and programming. At the University of Manchester, two professors, Williams and Kilburn, designed and operated successfully in June 1948 the first electronic digital computer to hold its programmes and data in the same store. Soon after developments at the University of Manchester, Cambridge University constructed at their Mathematical Laboratory, the Electronics Delay Storage Automatic Calculator which carried out its first fully automated calculation in May 1949.

Mainframe computers began to spread in universities which led to greater rationalization of investment in them. In the 1960's the Computer Board provided universities with their main computer as well as with departmental digital machines costing R50 000 or more. Machines covering the whole range of sizes both digital and analogue, were provided by the research councils for specified research purposes.

In the educational sphere at primary and secondary levels there was very little activity at the beginning of the 1970's. (Hooper and Toye, 1975) A number of projects were undertaken by individuals based in educational institutions or by the institutions themselves. Projects were also undertaken by commercial organizations such as IBM and I.C.L. Only later did SSRC and NDP-funded projects give impetus to the movement to know more about CAL in education and commerce.

Significant projects instigated and developed during the 1970's were the Leeds University Project, Chelsea Science Simulation Project, and the Havering Computer Managed Learning System Project. Details of these projects are to be found in Computer assisted learning in the United Kingdom : some case studies; edited by Richard Hooper and Ingrid Toye. (1975)

In January 1973 the National Development Programme in Computer-Assisted Learning was launched. The origins of the National Development Programme can be pinpointed to December 1967 when the National Council for Educational Technology (NCET) decided to set up a Working Party with the following main terms of reference :

- To investigate the potential role of the computer as a component of educational and training systems in the United Kingdom taking into account as necessary, experience and trends in other countries.
- To outline a systematic programme of applied research and development which it would be desirable to encourage, aimed at exploiting the computer to the best advantage in education and training. (Hooper, 1974:59)

The Working Party which reported in 1968 recommended a "national research and development programme" with the following objectives:

- (a) To develop new equipment, software and instructional techniques to exploit the full potential of the computer as an educational resource.
- (b) To ensure from the outset compatibility among emerging computer-based learning systems.
- (c) To develop techniques to reduce the cost and promote the efficiency of computer-based learning.
- (d) To promote the production of a significant volume of instructional material of proven quality.
- (e) To provide for storage and dissemination of information and instructional material. (Hooper, 1974:59)

As a result of the Working Party Report, NCET decided to initiate a major feasibility study. The feasibility study report became the basis of a brief NCET document, published in 1969, called Computer-based learning: a programme for action. This document was written by a group chaired by Professor J Vaizey which had been set up to guide the work of the feasibility study team. Computer-based learning: a programme for action, set out the case for a five-year, £2 million programme.

The government, following much discussion and negotiation amongst interested departments, announced its approval of a five-year £2 million, national development programme in computer-assisted learning at the end of May 1972.

The aim of the National Programme was seen from the start to be firmly developmental. Owing to the relative novelty of CAL in the United Kingdom at the time, and given the average teacher's scepticism of paper feasibility studies and research reports, it seemed important for the aim to be very tangible. (Hooper, 1974) For CAL to become accepted by teachers and administrators in education, it was suggested that it had to be seen to be working and workable not in a laboratory environment but in a range of real educational settings. The National Development Programme in Computer-based learning enabled the computer to become established as a teaching instrument, and it produced a wide variety of materials which were used for day-to-day learning by a considerable and increasing number of pupils and students. The National Development Programme then recommended a period of consolidation to foster greater experience in using computer-assisted learning programmes, ready for a further advance during the 1980's.

This advance, as mentioned earlier, arrived with the appearance of the silicon chip. It highlighted the importance of the application of this technology. The question now facing the British Government was how education was to respond. In March 1980, a four-year Programme for schools, costing £9 million, was announced by the Under-Secretary of State at the Department of Education and Science. Two aims emerged as

the principal focus for this programme : the introduction of pupils to the new technology, its applications and effects, and the encouragement of teachers to make use of devices based on the technology to extend the means available to them for motivating pupils and helping them to learn. (Fothergill, 1983) The Programme was known as the Microelectronics Education Programme (MEP). The programme was to be responsible to the Department of Education of England, Northern Ireland and Wales, and its work was to be undertaken through contracts arranged with them and administered by the Council for Educational Technology. The Programme was aimed at primary and secondary schools in England, Northern Ireland and Wales.

In 1981 The Micros in Schools Scheme was established by the Department of Industry. This scheme made available to Local Education Authorities funds to assist secondary schools without a microcomputer to acquire one in order that their pupils could have "hands-on" experience. It was hoped that by the end of 1982 all secondary schools in the United Kingdom would have a microcomputer. From the beginning of 1982, the scheme was extended to those secondary schools already with equipment which would not be eligible for a grant. In July 1982 the Scheme was also extended to cover primary schools.

In 1982 the BBC Computer Literacy Project was launched. The aims of the project were to introduce pupils and adults to microcomputers. The idea was that they should learn how to programme and use the micro-computer. The project was built around two ten-part television series "The Computer Programme" and "Make the Most of Your Computer". It included a book, a linked microcomputer system complete with User Guide, a range of applications programmes and associated courses in BASIC, and numerous additional aspects of computing. These were provided by the National Extension College in Cambridge. An additional aspect of the BBC Computer Literacy Project, overall, was a postal referral service which was established to place viewers in contact with local sources of advice and to supply information generally. Other activities included the publishing of leaflets, developing familiarization and training courses linked to the project, and establishing wide contacts with people in the field of microcomputers.

2.4.2 Developments in Microcomputer Use with Learning Disabled Pupils

Following the launching of the MEP, the Council for Educational Technology submitted a proposal for £1.1 million of funding for work in special education. (C E T, 1981) Current developments and trends in microcomputer use in the United Kingdom with learning disabled pupils are inextricably tied in with the work of the MEP in the field of pupils with special educational needs.

After it had been decided to launch work in the special education sphere, the MEP's Advisory Committee agreed that the allocation of funds should be directed for the exploration and development of seven key areas.

- (a) The funding of regional curriculum development groups, coming together through the LEA's, as envisaged in the MEP Strategy document.
- (b) Eleven one-week teaching training courses over three years.
- (c) The establishment of four 'Special Education Microelectronic Resource Centres (SEMERC's) in parallel with the MEP's 14 regional centres. Each to have a regional role but also a specialism in:
 - (i) the blind
 - (ii) the deaf and language impaired (including dyslexia)
 - (iii) the physically handicapped
 - (iv) ESN(S) and autistic children.

£16 000 was allocated to each centre per annum as well as an initial £30 000 per centre for equipment and books.

- (d) £10 000 per annum granted for consultancy on communication aids.
- (e) £47 000 granted for two special investigations into
 - (i) the problems of access of physically handicapped and blind learners to CAL material;
 - (ii) the development of input devices for severely handicapped children.

- (f) The production of a Special Education issue of ACE (Aids for Communication in Education) to go to all special schools in Autumn 1981.
 - (g) £20 000 for the production of small devices for educational applications which would not otherwise be economically feasible.
- (Smith Ed, 1982:66)

Mary Hope, who is based at the CET in London became the National co-ordinator for special education in the MEP programme. Briefly, the MEP focused on giving practical help to teachers in the special education sphere in the following way:

- Information and advice about the use of microelectronics with children with learning disabilities, including in-service training;
- demonstrations of the software and hardware available, either at the SEMERC's, ACE or RIC's (Regional Information Centres), with advice about the latest devices and programmes available;
- a focus for discussion and debate about 'good practice', bringing together people with common interests or problems;
- funds for really original ideas for curriculum development;
- a growing stock of 'copyright free' software (which teachers may copy).

(CET, 1984:1)

The MEP programme has been extended to operate for six years (since March 1980) and £18m has been allocated so far to its functioning. When the Special Education programme was launched in 1981 a directory was opened which listed projects being undertaken throughout the United Kingdom.

In the first directory (which is regularly updated) in the region of 50 projects were listed as being currently undertaken. Institutions where projects were being undertaken included schools for the physically handicapped, educable sub-normal, maladjusted, and deaf. Numerous

comprehensive schools were also involved in projects aimed at their remedial pupils. Colleges and universities were involved as well.

Activities involved using programmes to aid remedial pupils as well as programmes being developed to stimulate mentally and physically handicapped pupils into purposeful activity. Programmes were designed to help pupils with reading, writing, spelling and maths as well as training them in skills such as perception, spatial orientation, manual dexterity and concentration. (CET,1981)

As mentioned earlier, financial assistance was given to help new projects. The MEP does not specify the kind of project that it will fund. It acknowledges that as far as software is concerned there seem to be enough imaginative ideas - especially for teaching pupils with severe learning disabilities. Proposals are more likely to be favoured if they encourage learning by discovery, exploiting the immediate interactive capabilities of the microcomputer. The Programme is aiming to see the generation of more programmes which require logical thinking, the planning of strategies and decision-taking or those in which the pupils themselves generate the specific information content. The Programme also feels that there is great scope for the use of simulations with learning disabled pupils. (CET,1984)

While aiming for the content of programmes as discussed above, the MEP has divided the special education projects they are funding into six categories. The first five relate to the special educational needs of the pupils they are designed to help:

- moderate learning difficulties
- severe learning difficulties
- sight impairment
- hearing impairment
- physical handicaps
- management.

By mid-1984 there were about 60 projects being undertaken throughout the United Kingdom in the areas mentioned above. (CET,1984) The

reason for encouraging these projects was because up to this time very little educational microcomputer software had been produced explicitly for children with special educational needs.

The MEP is interested in establishing whether the programmes available (including those being designed as part of projects) are suitable. To this end certain programmes which have been established as being potentially suitable for learning disabled pupils have been given to teachers at two or three schools to be 'tried out'. The MEP acknowledges that this method is not a scientific appraisal but at least offers the opportunity for the views of some who have used the material to be helpful to others who are looking for software suited to their needs. (CET, 1983) The MEP provides a software evaluation checklist to be used in assessing the programmes.

2.5 The Republic of South Africa

2.5.1 General Developments in Computer-Aided Learning

Since the end of the 70's there has been a significant increase in interest in computer use in South Africa. The infrastructure in White education is fairly sophisticated, and owing to South Africa's close links with Western countries, many advances made there are often absorbed into the local system. One of these advances has been the use of the microcomputer in education.

When computing burst onto the scene in South Africa it immediately faced certain problems. Before it could be implemented in any way in commerce, industry or education, certain shortcomings had to be overcome.

In respect of education a major problem was that of insufficient teachers suitably qualified to cope with teaching the new technology. In respect of the pupils there were further problems as many of them, (and here all population groups in South Africa; Asian, Black, Coloured and White are referred to) of school-going age are environmentally deprived in relation to education for a technologically-oriented

society. (HSRC, 1981)

Up to the early 1980's there was no computer application in schools. Computer science had been offered at universities and technikons as a subject and various large companies and private institutions offered courses in order to enable employees to become familiar with the computers being used in their companies (e.g. banks, insurance companies). Training in the educational field was far behind and educationists, in fact, pointed out that training for specialists in educational technology had been inadequate.

In 1981, the HSRC education report was published. This, as mentioned earlier, was one of the most extensive investigations ever undertaken in respect of education in the Republic of South Africa.

The HSRC education report gave considerable attention to educational technology. The computer was seen as a means to upgrade the standard of teachers, especially Black teachers. The report recommended that immediate attention should be given to the introduction of computers in education, and that a research committee should be established to initiate and undertake this research. The research committee published its Report during 1983.

During the late 1970's and early 1980's, however, a number of developments were in fact taking place in computing. Gregory (1983), Delpierre (1984) and Metrowich and Roux (1984) discuss a number of significant developments.

In August 1981 the University of the Western Cape (UWC) installed a mainframe-based PLATO system serving 64 terminals. This has since grown to an installation with 104 terminals of which about 80 are available to students. In 1982 the University embarked upon a five-year CAL plan encompassing four linked projects. These were envisaged as follows:

- (a) Validating and disseminating computer-based curricula in mathematics and sciences for pupils in final two years of school.
- (b) Extend (via terminals) above scheme to secondary schools, technikons and colleges of education in the Western Cape.
- (c) Research and development programme for mathematics and sciences, involving the participation of secondary schools teachers and tertiary level personnel.
- (d) Develop CAL expertise amongst teachers.

(Gregory, 1983:143)

Delpierre (1984) points out that the UWC PLATO project has worked reasonably well and that about 46 of the 66 academic departments are making use of it. He states that the Biochemistry Department at the University is the largest user of PLATO on the campus, based on hours of on-line time per student per year. He further points out that recent results (1982/3) have been encouraging with increased pass and reduced dropout rates.

During 1983, two TOAM computer-aided learning systems were acquired in S.A. from Israel. One TOAM (a Hebrew acronym for test and practice) system has been installed at a specially prepared room at the Molapo Technical Centre in Soweto, whilst the other is housed in a 12-metre long mobile trailer. The system consists of 32 terminals, a small mainframe computer and a printer.

Pupils perform badly in arithmetic at primary schools in Soweto (Metrowich and Roux, 1984), therefore researchers undertook to establish whether the situation could be improved by exposing pupils to the micro-computer terminals and software and thereby evaluate some of the claims made by the developers of the system with regard to the following:

- (a) The importance of the teacher in the total TOAM system.
- (b) The ability of the system to evaluate the performance of the pupils in arithmetic.

- (c) The effective use of the printout as a diagnostic tool by the teacher.
- (d) Strategies for the remediation of weaknesses as revealed by the computer.
- (e) The effectiveness of the computer programme in improving the performance of pupils.

(Metrowich and Roux, 1984:10)

TOAM was implemented at five primary schools. The system is not designed to give tuition but is rather a test and practice medium. The project is scheduled to run until the end of 1985 but, although still in its infancy, the pilot study has revealed some interesting findings. One interesting finding is that the performance of the pupils in the HSRC tests has implied that the grading by the computer is similar to the standard expected of pupils in the various grades in South African schools. (Metrowich and Roux, 1984)

At school level education authorities have been encouraging the introduction and use of microcomputers. There is as yet no fixed departmental policy, but numerous schools, both provincial and private, have taken the initiative to introduce computers in their schools. In the Transvaal and the Cape the emphasis has been on independent microcomputers. They have been introduced principally at the secondary school level although a number of primary schools have embraced them as well. Most of the applications in primary and secondary education have been with mathematics. Schools which have made the greatest advances in introducing computers have usually been those who are well endowed financially. Computer hardware and software are not yet standard departmental issue so only those schools with the finance or fund-raising capacity have been able to purchase the necessary equipment - which into the mid-1980's is still relatively expensive. As there has been no fixed directive from educational departments in respect of hardware and software, it has been left to those schools getting involved to decide how best they want to use the microcomputer in administration and the curriculum.

Obviously some kind of uniformity of policy had to be formulated in order to manage the new technology, and this is evinced in the research committee report - mentioned earlier - which was published by the HSRC in 1983.

The specific task of the work research committee resulted in nine sub-reports that were subsequently integrated in a work committee report. A full set of reports on The Computer in Education and Training were finally published. These constituted the following:

- Part 1 : The computer in education and training : findings and recommendations.
- Part 2 : The computer in education and training : supporting reports.
- Part 3 : Specifications for microcomputer systems in schools and other educational institutions.
- 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.

The recommendations made in the reports have yet to be fully accepted and implemented but as such provide a significant insight into the direction in which the educational authorities feel computing in South African schools should be moving. Recommendations were made in respect of education and training at tertiary, secondary and primary institutions as well as in the formal and non-formal educational sphere. A number of significant recommendations are noted hereunder.

The research committee suggested that a central, and other co-ordinating bodies should be established. Two such bodies, the National Advisory Council for Computers in Education and Training (NACCET) and a South African Centre for Computers in Education and Training (SACCET) were recommended. The former would concern itself with advising the relevant Ministers in government on the policy for the introduction and use of the computer in education and training as well as serving as a controlling body for the latter. SACCET would have the function of

co-ordinating the activities of regional centres as well as collecting, advising and disseminating information in respect of computers in education and training. The regional centres would, in collaboration with SACCET, function as follows:

- evaluation of educational courseware
- obtaining quality educational courseware and making it available
- distribution, storing and making information available on software
- giving advice to teachers, lecturers and other training personnel
- reviewing and evaluating specifications for microcomputer systems with feedback to SACCET
- reviewing and evaluating criteria for the evaluation of educational courseware with feedback to SACCET
- keeping computerized registers on individuals involved with computers in education and training and those developing programmes, and
- aiding the training of teachers (presenting courses, developing programmes).

(HSRC, 1983:64)

Other recommendations of the research committee, as mentioned earlier, were concerned with educational courseware as well as formal and non-formal educational applications and financing. An important aspect of the report highlighted the urgent need for promoting computer awareness and computer literacy. To this end the research committee suggested certain outline programmes for computer awareness and computer literacy.

Certain recommendations were made in respect of computer use with school pupils from Standards Two to Ten.

With pupils in Standards Two to Four it seemed evident from the research that initially the priority with this group would be computer awareness, rather than computer literacy. (For the purpose of the investigation, Computer Awareness was taken to mean the minimum knowledge required by a citizen to operate with reasonable confidence in

in a computer-using society; whilst Computer Literacy was taken to mean the knowledge and skills required to gain an understanding about computers, their uses, application and limitations, and their implications for society.) (HSRC, 1983:6) Pupils in Standards Two to Four would be guided to become familiar in handling the problems of interfacing with a machine, such as becoming familiar with the use of the keyboards.

It was suggested that Standard Five should be seen as a "bridging year" between the end of computer awareness in Standard Four and the beginning of "hands-on" computer literacy in Standard Six. It was recommended that in Standard Five, the majority of schools would teach computer literacy using written materials and visual aids such as films. It was firmly suggested, however, that primary schools which were in a position to introduce "hands-on" computer literacy, should be provided with material support from the authorities.

For pupils in Standards Six and Seven, it was recommended that computer literacy should be taught in a more formal manner using hardware supplied wholly by the education authorities. The problem, of course, existed that such a course of action might have to be delayed until all schools throughout the country had been provided with the relevant hardware. To overcome this, it was recommended that initially there should be two "levels" of computer literacy in Standards Six and Seven. Level 1, would be for schools with no, or inadequate trained staff. A "non-hands-on" literacy course using television and/or written material, would be used, supported if possible by audiovisual media. Level 2, would be operative in a school where there was the necessary staff to introduce "hands-on" literacy. These schools should be supplied with adequate quantities of computer equipment.

In Standards Eight to Ten the research committee noted that pupils in these classes would already be under pressure of a full curriculum of examination subjects and that computer literacy as such would be inappropriate. It was recommended, therefore, that "computer activity" should take the form of computer studies and/or computer clubs.

As yet there is no national or provincial policy in respect of microcomputer use with learning disabled pupils. Neither has there been any investigation directed towards this area of education. Schools and school clinics are left to their own devices as to what course they want to take when it comes to microcomputer use in remedial education.

As a later chapter deals with this subject in the local context, it will not be referred to here.

CHAPTER THREE

3.0 LEARNING THEORIES : THEIR RELATIONSHIP TO COMPUTER AIDED LEARNING

3.1 Introduction

There are many different kinds of learning. Learning can range from a simple response to the solution of a highly complex problem. Some learning theories have focused on simple low-level behaviours while others have been concerned with the processes involved in complex learning.

This chapter will concentrate on those theories of learning which have influenced computer aided learning in the past and which seem to hold the greatest potential for use - with microcomputers - in the future. Computer aided learning encompasses a very wide range of learning tasks and it is for this reason that learning theories at both ends of the learning continuum will be considered.

Within the field of psychology there has been a diversity of views regarding the concept of learning. The concept of learning that has dominated the field of psychology from the beginning of this century has been behaviourism. "Behaviourism emphasises that progress was to be made in psychology only through the elimination of such research topics as memory and mind while concerning oneself solely with observable phenomena - behaviour." (Chambers and Sprecher, 1983:90) J B Watson introduced this concept and stimulus - response (S-R) psychology became the traditional approach to learning in the United States.

During this phase in the field of learning, E L Thorndike developed the concept of "The Law of Effect". This concept states that learning which is accompanied by satisfaction on the part of the pupil is likely to be more permanent than learning which is accompanied by frustration.

(Callender, 1969) The reward received by the learner is said to "reinforce" his behaviour. In the 1930's B F Skinner introduced the idea

of operant conditioning, in which even the stimulus (S) was taken out of the S-R and the response (R) only - followed by a reinforcement - formed the main learning elements. The work of Skinner was well researched and documented and his ideas came to dominate the field.

Chambers and Sprecher (1983) suggest that recently psychologists have begun to raise questions regarding certain problems in the field. They are concerned with the lack of progress made in understanding cognitive concepts such as thinking, memory, perception and mental processes in general. While these questions were being raised by psychologists, microcomputers were making their appearance in schools and universities. The information processing activity of microcomputers was seen in many quarters to be analogous to the human brain in which concepts such as memory replaced stimulus-response bonds. This revolution resulted in experimental psychologists combining with linguists and professionals in the field of computer science to create a new field of cognitive science. It has been suggested that this field, concerned with understanding mental processes and making extensive use of the modelling capacities of computers, has brought an entirely new light to bear on the topic of learning.

Learning theorists generally agree that certain conditions are necessary for learning to take place. These are contiguity, reinforcement and repetition. Considering the above, the remainder of this chapter will be concerned with a discussion of the concepts of operant conditioning; the basic principles of cognitive theories, and the ideas of social learning theories.

In the course of discussing these theories, an attempt will be made to relate them to courseware design for microcomputer delivery.

3.2 B F Skinner and Operant Conditioning

As mentioned earlier, many writers cite the application of Skinner's reinforcement learning principles as the theoretical base for current computer assisted learning strategies. These learning principles were

incorporated and established in the practice of programming and programmed instruction.

Skinner (1968) maintains that there are three theories that characterize learning. These are: learning by doing, learning from experience and learning by trial and error. He states that these classical theories represent the three essential parts of any set of contingencies of reinforcement: learning by doing emphasizes the response; learning from experience, the occasion upon which the response occurs; and learning by trial and error, the consequences. He states that no one part can be studied entirely by itself, and all three parts must be recognized in formulating any given instance of learning.

Skinner endorses the point of view that an organism learns mainly by producing changes in its environment. Techniques have been devised to arrange what are called contingencies of reinforcement - the relations which prevail between behaviour on one hand and the consequences of that behaviour on the other - with the result that a more effective control of behaviour has been achieved. (Skinner, 1968)

Skinner refers to two principal conditions which control behaviour. He refers to the Law of Effect, mentioned earlier, and points out that it has been established that effects do occur and that they occur under conditions which are optimal for producing the changes called learning. He states that once a particular type of consequence called reinforcement has been arranged, certain techniques allow one to shape the behaviour of an organism at will.

Skinner carried out experiments with pigeons in particular, and discovered that if a pigeon autonomously performed a desired action at a specific moment and was immediately rewarded, it would repeat the action on the strength of the reward. If it were to carry out a second desired movement together with the first and again receive an immediate reward, it would repeat both movements in the future for the sake of the reward. Skinner maintains that the pigeon reacts this way as a result of "learning". Skinner was able, in this way, to inculcate specific behavioural

patterns in pigeons and then mould them into general behavioural patterns. (Hattingh, 1976)

Skinner states that considerably complex performances can be attained via successive stages in the shaping process; the contingencies of reinforcement being altered progressively in the direction of the required behaviour.

This, therefore, is Skinner's great discovery - that reinforcement must be used in order to shape behaviour effectively. Skinner states that it is important to apply as many reinforcements as possible. For the experimenter who wishes to make a given animal capable of a certain type of behaviour, the learning programme will consist of applying reinforcing contingencies, arranging as many opportunities as possible for satisfaction. Comparative studies show that a great deal of time is gained thereby, and that the subject advances much further and is capable of far more than could be foreseen. (Pocztar, 1972)

As mentioned earlier, after his experiments on pigeons, Skinner moulded these behavioural patterns on other organisms. He transferred the process to the classroom situation. Skinner acknowledges that there are some vital questions which have to be asked and answered when turning to the study of any new organism: What behaviour is to be set up? What reinforcers are at hand? What responses are available for embarking upon a programme of progressive approximation which will lead to the final form of behaviour? How can reinforcements be most efficiently scheduled to maintain the behaviour in strength? Skinner suggests that these requirements might be beyond the scope of the ordinary classroom teacher. An organism, he says, is affected by subtle details of contingencies which are beyond the capacity of the human organism to arrange. (Skinner, 1968) Skinner suggests that mechanical and electrical devices must be used. Mechanical help is required owing to the enormous number of contingencies which may be used.

Skinner suggested the use of a teaching machine to overcome the problem, and pointed out significant features of such a machine.

- Reinforcement for the correct answer is immediate.
- A teacher can supervise an entire class at a time, and pupils can proceed at their own rate.
- Gifted pupils can proceed more rapidly.
- Carefully designed material can be presented in which one problem can depend upon the answer to the preceding problem and where, therefore, the most efficient progress to an eventually complex repertoire can be made.
- Additional steps can be inserted where pupils tend to have trouble, and ultimately the material will reach a point at which the answers of the average child will almost consistently be correct.

3.2.1 Linear Programming

The 1950's saw the advent of programmed instruction based on the operant conditioning principles of Skinner. These ideas dominated the field of psychology for many years. The principles of programmed instruction were based on the laws of behaviour discovered by Skinner in his laboratory experiments.

The linear form of programmed instruction is a result of Skinner's research. This form of programmed instruction is characterized by the following principles:

(a) The step by step principle

The effectiveness of the learning process depends on the frequency of reinforcements. When teaching a specific discipline this means that measures must be taken to provide as many opportunities as possible for reward or reinforcement. This will mean dividing the information into small units. In other words, if the units are smaller there will be more reinforcers which will thus occur more frequently. Therefore learning will be more effective.

(b) Activity

This principle suggests that pupils must act on each "unit of information" by means of exercises provided to assimilate it.

(c) Success

Pupils will learn rapidly if they are given the possibility of succeeding as often as possible. The activity required for the assimilation of knowledge must lead to success.

(d) Immediate verification

For there to be satisfaction and success, the pupil must know that his action is correct. Hence he must be able to compare his reply with the correct answer before passing on to the next step; there must be immediate verification.

(e) Learning progresses logically

In the process of learning, activity should increasingly centre on what is to be taught. An attempt must be made to avoid all superfluous elements likely to distract the pupil's attention. Learning progresses logically. In this way it will be possible to speed up the process, i.e. to provoke increasingly complex modes of behaviour, gradually increasing in difficulty.

(f) The principle of individual pace

Pupils must be left to proceed at their own pace: This is the principle of "individual pace"; in this way instruction can be individualized. (Poczter, 1972:45)

3.3 Applicability of Skinner's Theories to CAL

In outlining Skinner's linear programme it will be observed that his views are applicable to the drill and practice and tutorial forms of computer aided learning. What is meant by these terms?

- Drill and practice is commonly defined as a mode of computer delivery designed to integrate and consolidate previously learned material via practice on a computer. It serves as a supplement to other forms of instruction.

- Tutorials. The tutorial programme assumes the role of teacher and presents the material in a programmed learning format. The pupil moves from one step to the next by answering questions and may be branched to remedial or review segments as well as more advanced levels of the programme. The usual format is that following the presentation of the material, the computer questions the pupil about the information. If the pupil correctly answers the question, the computer then provides more advanced material for consideration. If the pupil incorrectly responds to the question, the computer presents the correct answer and requires the pupil to enter the correct answer through the keyboard in order to proceed. In some cases the computer also provides help when so requested by the pupil.

Drill and practice programmes in use today, although based on the earlier programmed instruction models, are far more advanced in what they are able to accomplish. A typical drill and practice programme works on the basis that the programme is content free so that the material is supplied as required by the user. In line with Skinner's principle of "small units" of information, the form of the input usually consists of a series of lines. The first part of the line would be the material requiring a response from the pupil; the second part of the line consists of the answer to the question posed in the first part of the line.

For example:

Question 1 / Answer 1
 Question 2 / Answer 2
 etc.

Pupils interacting with drill and practice programmes are directed through a predetermined series of steps. These are questions. The pupil proceeds depending on whether his answers are right or wrong. This concept has much in common with programmed learning principles, but the difference here, with microcomputer delivery, is that the material on the programme can be prepared which takes account of the level of performance of individual pupils. These pupils can be routed through particular sequences depending on how rapidly they acquire the skills being taught. The sophisticated nature of microcomputers allows them to monitor pupils'

progress. Rostron and Sewell (1983) point out that more sophisticated analyses can sometimes be devised to ascertain whether an interaction is too advanced and complicated for the pupil - or too easy. The level of response required can then be made simpler or more difficult depending on the circumstances.

When the monitoring task is taken away from the teacher, he is able to pursue a more high-level assessment of interactions that are taking place between the pupil and the computer. Skinner (1961) points out that if programmes are correctly designed, the role of the teacher in the process will be to follow the progress of each pupil and suggest collateral material which may be of interest. The teacher may also outline further studies and recommend changes to programmes of different levels of difficulty.

It has been argued that drill and practice programmes can become boring and that they offer little scope to the learning processes which involve problem solving and discovery. In the case of the learning disabled it can be argued, however, that there are certain basic skills which he has to acquire and which have to be practised so that they become second nature. The drill and practice mode of microcomputer delivery, and the environment in which the process takes place offers the pupil the right kind of "user-friendly", "problem-free" setting in which these skills can be acquired. Drill and practice delivery is sometimes the only way in which pupils can attain adequate practice either because of their speed of response or because of the nature of their handicap. In these situations the drill and practice programmes provide a very important supportive role.

Skinner (1968) states that it is inefficient and often impossible for a teacher simply to wait for a behaviour to occur so that it can be reinforced. He must induce the pupil to act, but he must be careful how he does this. Getting him to act on a given occasion may interfere with raising the probability that he will act in the same way in the future. He suggests that the best way to help the pupil arrive at an answer or piece of information that he is trying to recall is to give him a strong

hint or even the whole answer. Skinner concedes, however, that this might not be the best way to make sure that he will recall it in the future. Skinner maintains that the better the teacher, the more important it is that he free the pupil from the need for instructional help.

The above views expressed by Skinner in respect of pupil control are significant when considering the design of tutorial programmes for micro-computer delivery. In this type of learning situation, the micro-computer assumes the role of adviser, and the learning strategies involved are concerned with presentation of material and questions, hints and help messages to assist the pupil, as needed, to achieve the correct answers, followed by reinforcement of the correct responses. In some cases, the pupils can be offered various options of selecting levels of difficulty. The pupil can also miss out various sections of the programme if so desired. In the tutorial mode of delivery the pupil has a certain amount of control over what he is doing when he doesn't have to adhere rigidly to the structure of the lesson from beginning to end. Very often programmes in the tutorial mode have what is known as a "menu". This "menu" gives the pupil a choice as to where he wants to enter the lesson. This allows the pupil to select options that control both the lesson content and preparation.

3.4 Cognitive Theories

Cognitive learning theories emerged from the field of cognitive psychology which is the science of human information processing. Its subject matter, often called cognition, concerns the kinds of information humans have in their memories, and the processes involved in acquiring, retaining and using that information. Collectively, these processes are called cognitive processes. By studying cognition, psychologists hope to achieve a deeper understanding of how humans perform everyday activities ranging from perceiving to remembering to problem solving. (Wessells, 1982).

Reynolds and Flagg (1977) discuss three disciplines which have made an important contribution to the developing interest in higher mental

processes focused on in cognitive psychology. These are computer science, information theory and linguistics.

(a) Computer Science

Psychologists have invariably been interested in modelling and models. The development of the field of computer science gave some psychologists a new model, as well as a taste for structuralism and simulation as a research tool. Computer Science provided a rich source of powerful concepts that were applicable to previously ignored aspects of human cognitive functioning. (Reynolds and Flagg, 1977) Possibly the model utilized most often to describe human higher processes was that which viewed human thinking as analogous to computer processing. Psychologists were more interested in the thinking analogy than the machine analogy. Psychologists hypothesized that perhaps the way a programme works inside a computer provides a good analogy to the way the mind works inside the brain. A computer programme is not a machine but a way to run or control the machine, so it was the routines that run the machine that interested psychologists and not the machine itself. The impact of computer science was, therefore, to supply a powerful model for the way human higher processes may function.

(b) Information Theory

Closely related to the impact of computer science was the effect of exposure to the new field of information theory. (Reynolds and Flagg, 1977) This theory was constructed by researchers in the late 1940's. Its purpose was to help in solving the problem of coding messages efficiently. Questions that researchers in the field of cognitive psychology asked concerned the nature of human cognitive capacities. Investigators theorized about cognitive capacities by using concepts from information theory and communications engineering. (Wessells, 1982) Human issues that psychologists have learned to phrase in information theory terms include problems of information capacity, limitations on processing capacity, and the serial/parallel distinction as well as questions relating to ways of overcoming capacity or processing limitations. Psychologists borrowed systems terms and concepts like information flow, signal, filter, and band width from information theorists.

(c) Linguistics

Computer science and information theory provided some alternative models, new terminology, and new concepts for human experimental psychologists, but it was in the field of linguistics that new models were added and where radically different conceptions of mind were introduced that helped prepare the way for cognitive psychology. (Reynolds and Flagg, 1977) Theoretical criticism of Skinner's views emerged in the late 1950's; one of which pointed out the inadequacies of the prevailing paradigm and offered a totally new conception of human functioning based heavily on logical formalism and Cartesian propositions of innate intellectual structures. This new emphasis on Cartesian rationality was seen by some as a "healthy antidote to the prevailing overdose of rigid empiricism". (Reynolds and Flagg, 1977:9) It gave some psychologists a better appreciation for at least the possibility of innate human functioning. Researchers felt that the kind of rules postulated for linguistics could reveal something about rule-governed behaviour in the people who used language as well. Many researchers came to recognize the centrality of language to human functioning.

Cognitive psychology, today, is defined partly by what it does and partly by its subject matter - the higher mental processes. These comprise the total set of processes by which humans acquire, store and use information. They include processes like transformation, elaboration and recovery. When terms such as sensation, perception, and recall are used, they refer to hypothetical stages in a more continuous stream of processing.

This general way of viewing human functioning raises some equally general kinds of questions in respect of information processing situations. What information was attended to? What was stored? How did new information interact with, and perhaps alter, information already stored? How was the information used in behaviour?

Reynolds and Flagg (1977) point out that although cognitive psychologists have many different specialities, emphases, and methodologies, there are a number of things on which they all seem to agree. These psychologists believe in:

- The importance of the selection of stimulus information. Most of the time more information impinges on us than our limited capabilities can handle.
- The importance of selecting appropriate processing strategies to meet the demands of the task.
- The development of cognitive structures. After repeated applications of processing strategies, stable cognitive structures emerge.
- The interrelated functions of the parts of the human mind as a coherent system.
- The constantly active nature of cognitive processes. The system is always active and at work.

(Reynolds and Flagg, 1977:12)

Cognitive theory recognizes the importance of reinforcement, but does not give it the central importance accorded by Skinner. It indicates that learner behaviour sets in motion a process that depends on external feedback, which involves confirmation of correct performance. (Chambers and Sprecher, 1983)

An important concept contained in some cognitive theories is the executive control process. This process controls cognitive strategies relevant to learning and remembering in relation to such important activities as controlling attention, encoding of incoming information, and retrieval of stored data. Considering cognitive theory overall, the following kinds of processing during any single learning act could include:

- (a) Attention - selection among incoming stimuli
- (b) Selective perception - encoding selected items for storage in short-term memory
- (c) Rehearsal - maintaining data in short-term memory
- (d) Semantic encoding - preparing information for storage in short-term memory
- (e) Retrieval - searching and restoring information in working memory

- (f) Response organization - selecting and organizing performance
- (g) Feedback - the external event that sets in motion the process of reinforcement
- (h) Executive control process - selecting and activating cognitive strategies.

(Gagné and Briggs, 1979:154)

3.5 Applicability of Cognitive Theories to CAL

Cognitive learning theories are most applicable to the design and development of the tutorial mode of microcomputer delivery. Robert M Gagné has been active in pioneering this view.

Gagné (1981) states that learning has a different form depending what is being learned. Learning tasks can be categorized into several different types, and these different types require different teaching strategies. In planning CAL, these strategies can be cast in the form of "prescriptions", or directions for the programme to follow in designing instruction.

One of the first steps in designing CAL so as to take advantage of principles derived from theory and research, is to categorize the type of learning outcome. This is done by examining the target objective of the lesson, and identifying what type of performance is expected of the learner after he has learned.

Gagné and Briggs (1979) have described these learning outcomes in the following way:

- (a) Intellectual Skills - Intellectual skills are the capabilities that make the human individual competent. They enable him to respond to conceptualizations of his environment. They make up the most basic and at the same time the most pervasive, structure of formal education. They range from elementary language skills like composing a sentence to the advanced technical skills of science, engineering, and other disciplines.

(b) Cognitive Strategies - These are special and very important kinds of skills. They are capabilities that govern the individual's own learning, remembering and thinking behaviour.

(c) Verbal Information - Most humans have learned a great deal of verbal information, or verbal knowledge. We have available in our memories many commonly used items of information. Much of this information is stored in memory, but it is not necessarily "memorized", in the sense that it can be repeated verbatim. Something like the gist of paragraph-long passages are stored in memory and recalled in that form when the occasion demands.

(d) Motor Skills - A capability that human beings are expected to acquire is a motor skill - such as riding a bicycle, steering a car, using a can opener. At school, pupils are expected to know how to hold a pencil and print, cut out things, and use a ruler. Despite the fact that school instruction is so largely concerned with intellectual functions, well educated people are not expected to be lacking in certain motor skills.

(e) Attitudes - Most people have attitudes towards certain things, persons and situations. The effect of an attitude is to amplify an individual's positive or negative reactions toward some person, or thing or situation. (Gagné and Briggs, 1979:49)

Each of these categories has at least one critical attribute that distinguishes it from others, and that makes it possible for the designer of instruction to determine into which category a given learning task fits. The learning outcomes which are most likely to be aimed for in CAL are, according to Gagné, Wager and Rojas (1981), the following:

(a) Verbal information, and (b) the subordinate of intellectual skills which can be enumerated as; concrete concepts, defined concepts, rule and problem solving.

Once the learning outcome, or outcomes, of a lesson have been established, a designer of CAL software is in a position to proceed with a sequence of steps that will "teach" the pupil interacting with the computer. The "teaching" referred to is done by the presentation of a series of

displays that support or enhance learning. The support for learning occurs by means of several steps called events of instruction. The functions served by the various events of instruction in an act of learning can be listed as follows:

- (a) Gaining attention
- (b) Informing the learner of the objective
- (c) Stimulating recall of prerequisite learnings
- (d) Presenting the stimulus material
- (e) Providing "learning guidance"
- (f) Eliciting the performance
- (g) Providing feedback about performance correctness
- (h) Assessing the performance
- (i) Enhancing retention and transfer.

(Gagné and Briggs, 1979:157)

Depending on the learning objective and the intended learners, the planning of specific CAL displays to represent each of the nine events is subject to variation. For example, if the learners are new to CAL, event No 1 of gaining attention may not need to concern itself with general alertness, but may need to assure that learners watch the screen rather than looking at the keyboard.

The nine events of instruction require different specific forms depending on the category of learning outcome being taught. The planning of CAL instruction needs to make potential provisions for the display of frames containing print and diagrams to reflect all of the nine events of instruction. The sequential order of these events is roughly from one to nine, although reversals within this sequence may sometimes be desirable. There are a number of types of CAL each of which has different characteristics with regard to the events of instruction usually included. The most common types are drill and practice, tutorials and simulations. The applicability of Skinner's operant conditioning to drill and practice has already been discussed. A more comprehensive form of instruction is exemplified by the tutorial programme, which could conceivably contain all nine events of instruction. As an instructional form, the tutorial mode of delivery is usually considered to be "primary" instruction, as opposed to "supplementary" instruction.

In other words, a good tutorial programme ought to be able to stand on its own. The tutorial lesson can probably benefit most through the application of principles of instructional design.

(Gagné, Wager, Rojas, 1981)

Tutorial programmes come in two general forms, linear and branched. The linear form is the most common and can be represented in the following way. (Fig. 2)

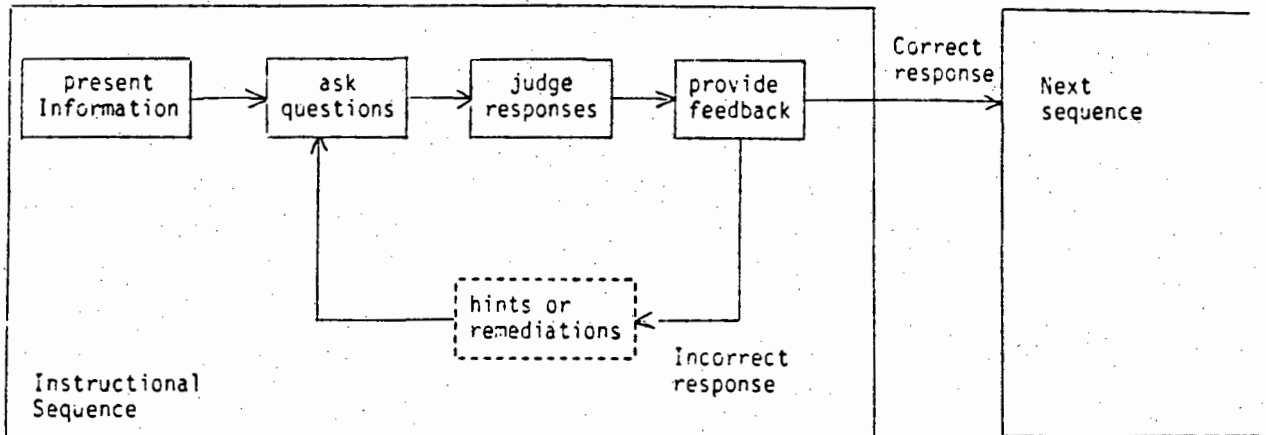


Fig. 2 Typical Procedure for Tutorial Programmes

(Gagné, Wager, Rojas, 1981:21)

In this form of instruction, the learner is presented with an instructional sequence consisting of text presentations, questions and feedback. There may be a large number of instructional sequences in a single lesson, but they all follow the same format. This format has been incorporated into computer-based authoring programmes, so that relatively naive computer users can create their own lessons. When prompted by the computer, the user of one of these authoring programmes provides the text that the learner will receive, the question that the learner will be asked, and the feedback that will be given.

In a tutorial programme, the software designer usually starts with the event "present stimulus". They then ask the learner a question followed by providing feedback. This sequence is then repeated with more information, questions and feedback. In most cases the software designer is employing only three events of instruction. It is possible, however, to provide additional instructional events.

Figure 3 represents the "events of instruction" paradigm for a tutorial programme in which these events perform different functions within the text displays of a lesson. (By "text" is meant the initial statement which appears on the screen to indicate to the pupil what he is to learn.) (Fig. 3)

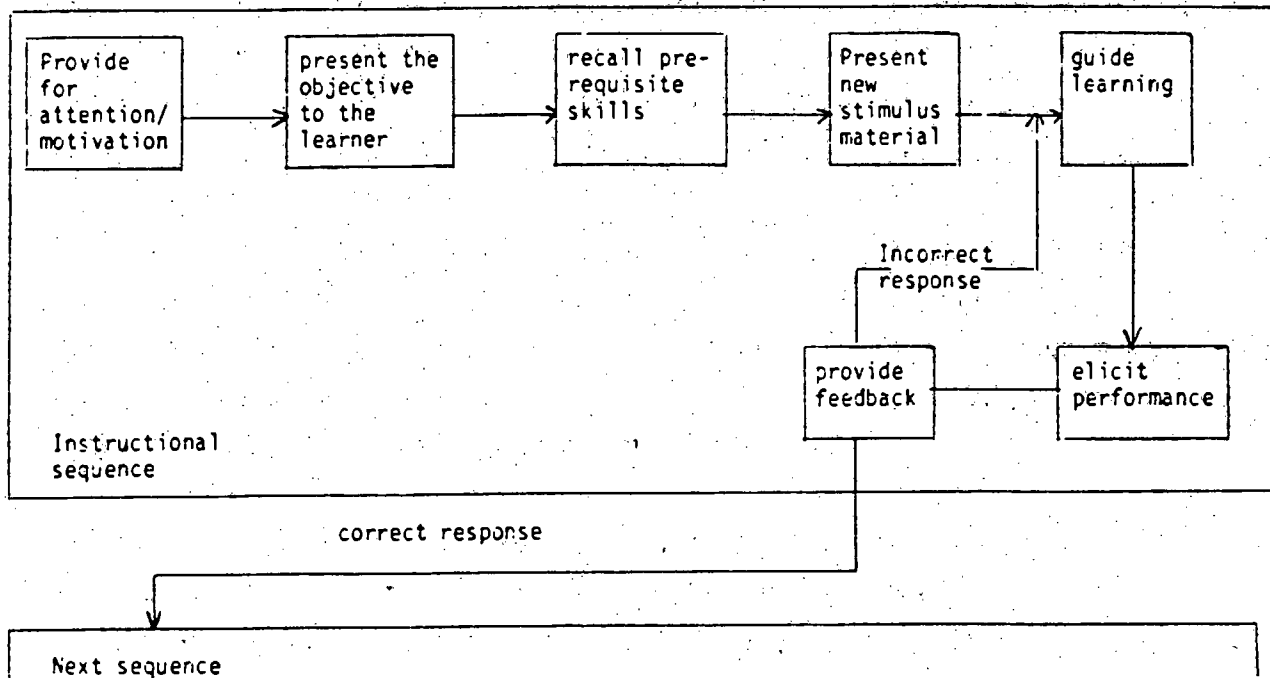


Fig. 3 Procedure Incorporating Additional Events of Instruction

(Gagné et al, 1981:23)

One or more displays may be used for any particular event presented, but in general, the sequence follows that as shown in Fig. 3. (Gagné, Wager, Rojas, 1981) The last two events, assessing performance, and enhancing retention and learning transfer, may be grouped at the end of the lesson or provided off the computer in another medium.

Gagné's concern with attention and expectancy represents an attempt to "introduce motivation into what was formerly a fairly rigid concern with simple response and reinforcement." (Chambers and Sprecher, 1983:100) Educationists believe that the inclusion of these steps, especially, and the other steps in the nine events of instruction in tutorial sequences can be of significant assistance to many designers of microcomputer software.

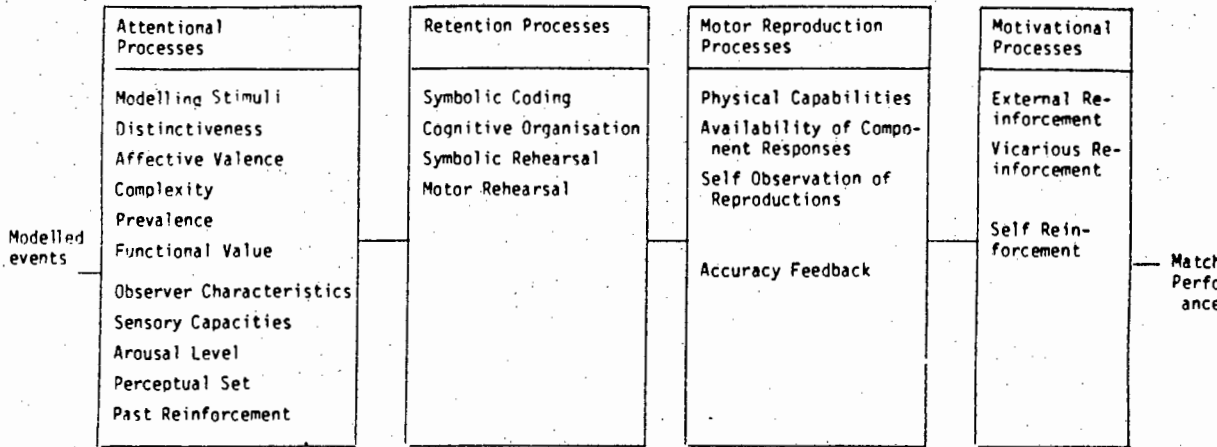


Fig. 4 Component Processes Governing Observational Learning in the Social Learning Analysis

(Bandura, 1977:23)

(a) Attentional Processes

An individual will not learn much by observation unless he attends to and perceives accurately the significant features of the modelled behaviour. Attentional processes will determine what is selectively observed in the profusion of modelling influences to which one is exposed, and what is extracted from such exposure. People with whom one regularly associates will be observed more often than others and are likely to influence behaviour strongly. Particular individuals within a group with which one associates are likely to command more attention than others. The functional value of the behaviours of different models is important in determining which models will be observed and learned and which will be ignored. An extension of this point is to be found in the activity of television viewing. Many people, both children and adults, spend much time watching television and are therefore exposed to a myriad of models which catch their attention. The extent to which the derivation of benefit from observing models is obtained depends on the observers' capacities to

process the information received from the observed experiences. Bandura suggests that an individual's perceptual set, derived from previous experiments and situational requirements will determine which features they concentrate upon in their observations and the extent to which they will interpret what they see and hear.

(b) Retention Processes

In order for an individual to be influenced by observation of a modelled behaviour, he must be able to remember it. These observed models must be committed to memory in symbolic form. The individual can refer to these symbols in order to imitate a behaviour. The advanced capacity for symbolization in humans is the factor that enables the individual to learn much of behaviour by observation. Observational learning relies on two representational systems - imaginal and verbal. Some behaviour is retained in imagery. Sensory stimulation activates sensations that give rise to perceptions of the external events. As a result of repeated exposure, modelling stimuli eventually produce enduring, retrievable images of modelled performances.

This implies that at a stage in the future, images (centrally aroused perceptions) can be recalled that are obviously, physically absent. Visual imagery contributes significantly to observational learning during early stages of development when verbal skills are lacking, as well as in learning behaviour patterns that do not lend themselves readily to verbal coding. The second representational system, which probably accounts for the notable speed of observational learning and retention in humans, involves verbal coding of modelled events. By converting visual information into a verbal code by actually describing a series of actions by a model facilitates acquisition, retention and reproduction of the behaviour later on. It is also important for an individual to rehearse mentally or actually perform modelled response patterns as this assists in the retention process.

(c) Motor Reproduction Processes

This component of modelling involves the converting of symbolic representations into appropriate actions. Reproduction of behaviour is

achieved by organizing one's responses spatially and temporally in accordance with the modelled patterns. Bandura suggests that behavioural enactment can be separated into cognitive organization of responses, their imitation, monitoring, and refinement on the basis of informative feedback. In the early stage of re-enacting a behaviour, responses are selected and organized at the cognitive level. The amount of observational learning that will be exhibited behaviourally partly depends on the availability of component skills. Learners who possess the constituent elements can integrate them without difficulty in order to produce new patterns. If, however, some of these response components are lacking, behavioural reproduction will be faulty. These subskills must then be developed by modelling and practice. Where actions from ideas do not approximate to required behaviour at first attempt, corrective adjustments must take place. This must occur via informative feedback from performance, and from focussed demonstrations of segments that have been only partially learned.

(d) Motivational Processes

Social learning theory makes a distinction between acquisition and performance because an individual will not enact everything that he has learned. An individual is more likely to enact a modelled behaviour if it results in an outcome that he values than if it is devoid of reward. Observed consequences influence modelled conduct in a similar way. Among the many responses acquired observationally, those behaviours that seem to be effective for others are favoured over behaviours that appear to have negative consequences.

Owing to various factors governing observational learning, the provision of models, which may even be significantly prominent, is no guarantee that similar behaviours will be created in others. Imitative behaviour can be produced without considering the underlying process. A model who repeatedly demonstrates desired responses, instructs others to reproduce the behaviour, prompts them physically when they fail, and then rewards them when they succeed, may eventually produce matching responses in most people. In a given situation the

failure of an observer to match the behaviour of a model may result from any of the following: not observing the relevant activities; inadequately coding modelled events for memory representation; failing to retain what was learned; physical inability to perform, or experiencing insufficient incentives.

Bandura, like Skinner and Gagné, takes a stance on the role of reinforcement in observational learning. Bandura (1977) states:

According to the social learning view, observational learning occurs through symbolic processes during exposure to modelled activities before any responses have been performed and does not necessarily require intrinsic and extrinsic reinforcement...Reinforcement does play a role in observational learning, but mainly as an antecedent rather than a consequent influence. Anticipation of reinforcement is one of several factors that can influence what is observed and what goes unnoticed. (Bandura, 1977:37)

3.7 Applicability of Social Learning Theory to CAL

Modelling influences serve to transmit information to observers as to how responses can be synthesized into new patterns. The response information can be transmitted by physical demonstration, pictorial representation or verbally. It can be suggested, therefore, that a significant amount of social learning takes place as a result of casual or directed observation of daily performed behaviours. Liebert, Neale and Davidson (1973) and Bandura (1973) point out that people are also influenced by other types of media. This can be via newspapers, television or films, for example. What they see or read about can convey to them various attitudes, emotional responses and new styles of conduct. It can be argued that the basic modelling process is the same regardless of whether it is transmitted from human to human or via the mass media. It can be suggested that forms of modelling such as television and films can be more effective in conveying their "message" than words, for example. People will often prefer to "watch the film", rather than "read the book". Both children and adults can easily become addicted to television, and it therefore doesn't take much to get them in front of such a device.

Microcomputers are rapidly becoming part of many households. In many cases it does not take much to compel both children and adults to sit at the console and interact with much of the software currently available which can be educational or recreational. With the myriad of media available nowadays, it can be argued that "symbolic" modelling can replace the role of the parent, teacher and other traditional role models in the social learning situation. As suggested above, the microcomputer with its associated software can go a long way to providing new roles for modelling. The implications of social learning theory seem most appropriate for the type of learning that can occur in numerous CAL simulations. Chambers and Sprecher (1983) suggest that although real models are not used in such simulations, the microcomputer provides a reality situation in which the pupil may learn vicariously through interaction with the model. In such cases the reinforcement can occur as a result of pupil responses to the model. The pupil responses can bring about a change in conditions, but he can control the situation and thereby be positively reinforced as he makes his decisions.

When interacting with simulation software the pupils can be provided with certain instructions to guide them in their learning. This can form an important component of the exercise. In this way the pupils can be provided with information relating to content, structure and goals of the simulation. In addition to this, instructions can be provided to inform the pupils of the benefits of adopting the modelled behaviour. This can result in the development of expectations that can serve to reinforce the learning. The simulation software can be used a number of times with a single pupil thereby enabling optimal interaction with the microcomputer thus enhancing retention and allowing for feedback which will improve the modelling to be acquired.

From the motivational point of view, the microcomputer should provide a model that is as human-like as possible. Manion (1985) states that CAL simulation programmes imitate a real situation and/or they model the underlying characteristics of a real phenomenon. Pupils must interact with and become part of the simulated reality. While

simulations may incorporate many features of games, their real power comes from their "capacity to teach about problem-solving". They are effective in helping pupils and students to learn such diverse concepts as driving a car, trading on the stock-market, or the effects of stress on the heart. Simulations should be used when and/or after base principles and concepts are learned so as "to integrate them into the context of a meaningful problem". (Manion, 1985:27)

Characteristics of high-status models can be used in order to reinforce a desired model behaviour. At the same time, attention should be given to relevancy of subject matter as this can affect performance.

Cognitively, simulations involve both the application and analysis levels of learning. Much of this activity is still beyond the scope of current microcomputer hardware and software although software is in existence that approximates to social learning theory. With rapid advances in both the hardware and software spheres, the prognosis for employing social learning theory in CAL in the near future is encouraging.

3.8 Applicability of Learning Theories to CAL with Learning Disabled Pupils

It will be appropriate at this point to consider how aspects of these theories have specific applicability to CAL with learning disabled pupils. The area to be focussed on here is cognitive development in children. The reason for examining this area of development is because early faulty cognition in a child is one of the main reasons why that child might develop a general or specific learning disability later on. This section will attempt to point out how diagnosis and early intervention via prescription using a microcomputer might assist in remediating faulty cognitive development.

When looking at the cognitive development of children we are looking at the child from the earliest of ages. The primary characteristics of learning during this period involve basic skills development that to

a large extent precedes academic learning. Bloom (1964) points out that a large portion of learning takes place during this time. He states that 50% of all growth in intelligence takes place between birth and the age of four years. These early stages of development can be regarded as "critical periods" for learning. (Behrman, 1984)

Cognitive skills are the collection of mental abilities that enable one to know and to be aware. Terms used to describe cognition include the ability to think, conceptualize, to use abstractions, to criticize and to be creative. (Lerner, 1976). It refers to a person's ability to acquire, interpret, organize, store, retrieve and employ knowledge. These cognitive abilities develop at all stages of a child's life, and occur largely as a result of his interaction with his physical environment.

Jean Piaget, a Swiss psychologist, spent much of his life studying the cognitive development of children. He concluded that cognitive growth occurred via a series of invariant and interdependent stages. He stated that at each stage a child was capable of learning only particular cognitive skills. The psychology of Piaget is developmental. The purpose of his approach is to explain in a self-supporting and logically consistent manner the way in which a new-born baby, totally ignorant of the world into which he or she has been born gradually comes to understand that world and to function competently in it. (Richmond, 1979)

If a child, because of a physical handicap, or some other reason is unable to move about or interact with his environment, he will be deprived of the opportunity to act upon his environment. Goldenberg (1979) suggests that the inability of these children to learn normally or act upon the environment may create secondary handicaps because they are not able to have the normal experiences of the world to build information upon.

Learning disabilities theorists suggest that the theories of cognitive development have implications for understanding pupils with learning

disabilities. (Lerner, 1981) Tests such as the Illinois Test for Psycholinguistic Abilities (ITPA) are designed to show a pathway of abilities which can be used for diagnostic purposes.

The ITPA is able to assist in establishing a child's strength and weakness by breaking down the intellectual functioning of the child into its individual contributing components. In this way it can be established whether a child with learning disabilities has a developmental imbalance. Other significant factors that might contribute towards a child's learning disability could be inadequate cognitive structures, faulty concept development and disorders in non-verbal and verbal thinking. (Lerner, 1976). These disorders could have occurred during the child's early periods of cognitive development as a result of his not being able to interact with his environment in a manner which is considered crucial to his development at that age. When faulty cognitive development has been diagnosed, there are suggested strategies as to how to remediate the problem. Lerner (1976) suggests two contrasting ways: (a) The Stimulus-Response approach which is a direct extension of Skinner's learning theory, and (b) The Hypothesis-Testing approach which draws on the ideas found in Bandura's Social Learning theory, and which lays emphasis on "inquiry", modelling and "discovery" learning.

It is suggested that the microcomputer can be employed to enhance the teaching of cognition as it applies to the two approaches above.

3.8.1 Stimulus - Response Theory of Learning

The theory behind this approach suggests that learning takes place as a result of conditioned and mechanical connections between environmental events and the response of an individual to those events. The Stimulus-Response Theory has, as has been pointed out earlier, generally been attributed to Skinner and it will therefore not be necessary to go into it here in great detail.

The theory suggests that associations are formed as a function of external stimulus conditions, and an assumption of this view is that cognitive

learning of complex processes is similar to the learning of simple skills. In addition, the view postulated above assumes that explanations of simpler kinds of learning provide adequate explanations of concept learning and cognition. (Lerner, 1976).

The Stimulus-Response theory emphasizes the importance of structure, overlearning, reinforcement and drill. A programme designed to teach the cognitive skills within the framework of this theory must specify what skill is to be learned after which the programme must be designed in such a way as to stimulate and reward the desired response. Teaching methods that emanate from this theory are behaviour modification and programmed instruction. The use of the microcomputer falls ideally into the last category. Where programmes can be designed which identify the objectives set for the pupil; and which simultaneously ascertain that the pupil is learning, the teacher possesses the possibility of harnessing a tool which can go a long way with remediating faulty cognition. The Stimulus-Response approach to cognitive development enables the teacher to design or use software which allows him or her to manipulate the environment in such a way that specific cognitive skills can be learned.

It will be appropriate to take a closer look at a typical programme that might meet the needs of a learning disabled pupil who needs to be taught various cognitive skills.

The programme in question is Meteor Multiplication Academic Skill Builders produced by Developmental Learning Materials of Texas, U.S.A. (Mason and Mason, 1982:26)

The programme delivery is straightforward and at no time is a frame too complicated or "stimulus-loaded" for the pupil to comprehend what to do. The initial stimulus is presented in small sequential steps which the teacher can control in respect of difficulty and length of time that the pupil has to make responses. (Fig. 5)

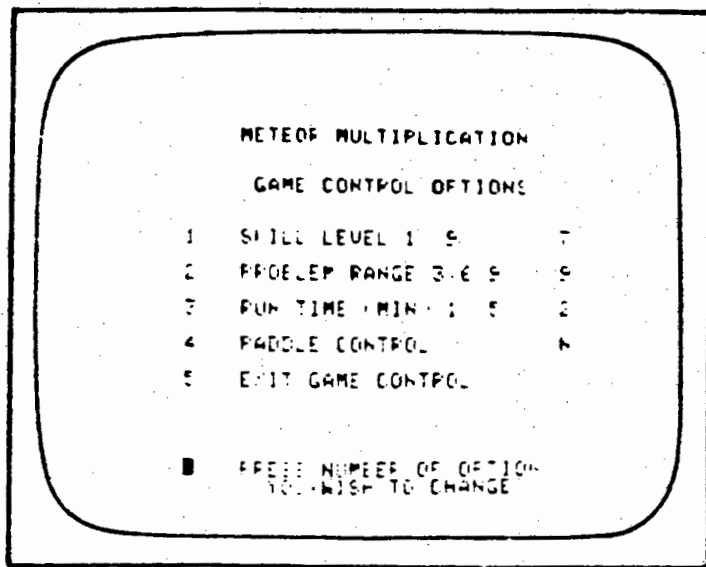


Fig. 5 Game Control Option

Unlike numerous commercially available programmes, the authors of this programme have based the learning activity upon a specified learning theory. Ogden Lindsley's Precision Teaching which is an offshoot of Skinner's work, was chosen as the basis for the teaching approach. (Mason and Mason, 1982)

This basis emphasizes the reduction of target activities to specific observable tasks; the recording of the frequency of occurrences; and the use of rewards to increase or decrease frequencies as appropriate.

The programme is designed to provide drill and practice in individual mathematics operations. Each response by the pupil is discrete and observable. There is a management system which allows the teacher to intervene in respect of skill level and length of time that stimuli will be presented. A record is also kept of correct responses.

(Fig. 6)

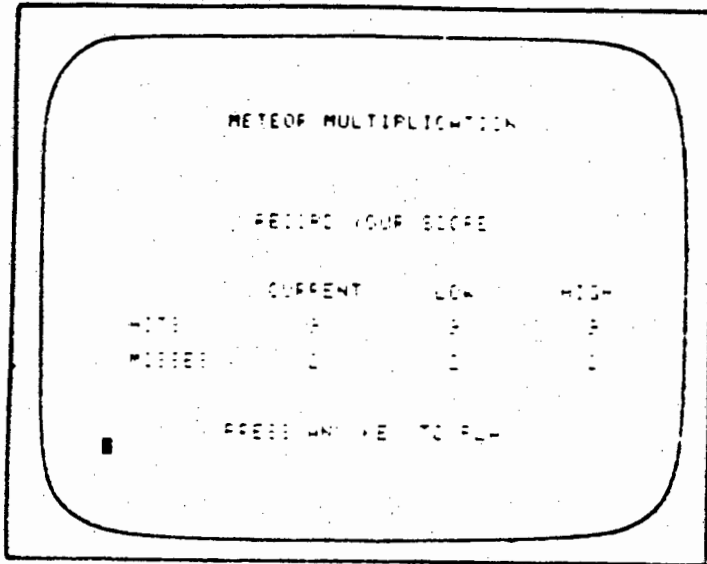


Fig. 6 Recording of Scores

A comprehensive manual accompanies the programme which explains to the teacher how to record the data from the interaction and thus use it for diagnostic purposes. The manual also provides a complete explanation of how to interpret the data, and suggests techniques to improve results.

Besides being based on a proven approach to learning there are a number of other aspects which are worth noting. For example, the two frames indicated below suggest how good use of graphics and sound with instant feedback have a possible motivational effect - especially in the light of the popularity of so-called Arcade Games.

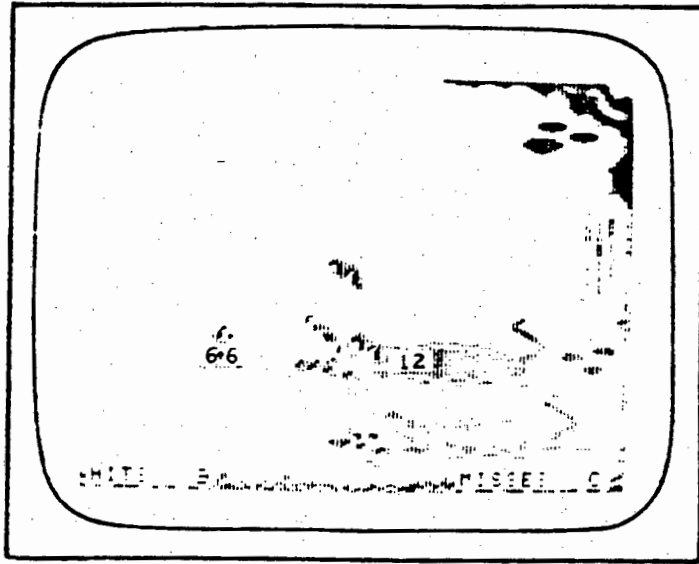


Fig. 7 Alligator Mix - addition and subtraction

In the above game (Fig. 7) called Alligator Mix - apples with addition and subtraction exercises float towards the mouth of an alligator. The pupil must decide whether the answer provided on the alligator is correct or not.

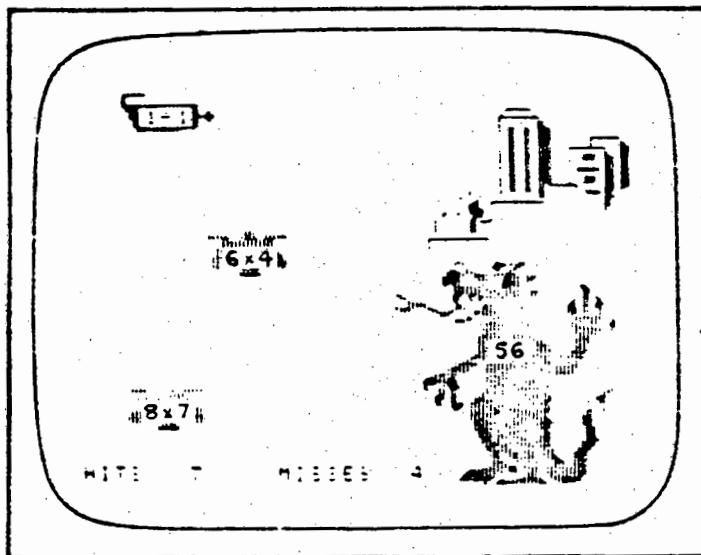


Fig. 8 Dragon Mix - multiplication and division

In the above game (Fig. 8) called Dragon Mix - a large dragon protects a city from invading forces that have multiplication and division exercises inscribed on them. The pupil directs the dragon's tongue of fire towards the correct answer.

It will be noted in each case the pupil receives feedback in respect of his score. This has an obvious motivational effect as the pupil attempts to score as high as possible. The graphics are interesting; sometimes amusing and limited stimulus is presented in each frame. Owing to the obvious sophistication of software nowadays where movement, colour and sound can be used, the pupil has the opportunity to acquire and improve numerous other skills. For example, pupils observed have been called upon to harness certain skills in tackling the programmes in question and these have led to a general improvement of that particular skill. Skills referred to here are directionality, fine motor movement, spatial relationships, visual perception and eye-hand co-ordination.

3.8.2 Hypothesis - Testing Theory of Learning

The hypothesis - testing views of cognitive learning suggests that learning is a highly active process of "seeking" behaviour rather than a passive process of "responding behaviour". Cognitive learning is approached as a kind of decision-making process. Pupils observe data, propose their own problems, construct hypotheses to their own problems, seek to reaffirm their hypotheses, and finally, formulate their own generalizations. Terms such as "modelling", "inquiry", "discovery" and "creativity approaches" have been used in regard to this learning approach.

Children who have interacted normally with their environment during their early years of development have probably indulged in these practices. Many children, however, who have handicaps; be they physical or some other particular learning disability have not done so or have not had the opportunity to do so.

Rostron and Sewell (1982) suggest that deprivation of proper interaction with the environment can have profound implications for pupils in their

earlier years. They will have been deprived of opportunities to learn via "inquiry", "discovery", or "creativity".

Kephart (1971) states that the early motor or muscular responses of a child represent the beginning of a long process of development and learning. He suggests that through the child's early movement and motor explorations, the child begins to find out about himself and the world around him, and his motor experimentation and his motor learning become the foundation upon which he models himself and upon which knowledge is built. To a large extent, so-called higher forms of behaviour develop out of, and have their roots in motor learning. (Kephart, 1971)

Ulric Neisser (1976) suggests that in a normal environment most objects and events are meaningful and that they possess implications about meanings and possible uses. Neisser suggests that individuals acquire knowledge about these possibilities and about meanings, and that, ultimately experience and interaction with the environment affect the development of knowledge.

Neisser endorses the view that early motor development is one of the foundation stones upon which cognitive development is built and suggests that where motor problems exist it can be predicted that cognitive development will be restricted. Neisser (1976) states:

People move. They turn their heads, shift their bodies, walk to the next room. The nature of perception cannot be understood without taking mobility into account... Information picked up as a result of ego-motion is thus systematically related to existing schemata, and in particular to a cognitive map or orienting schema of the nearby environment.
(Neisser, 1976:108)

The above quote suggests the development of schemata through "information pick-up" whilst moving around the environment. This means that the individual extracts knowledge through acquiring information about

situations. Rostron and Sewell (1982) point out that if the means by which information is acquired are disrupted, then, inevitably, the acquisition of knowledge is disrupted. One way of disruption occurring is, as pointed out, brought about by motor disruption. In addition, Rostron and Sewell (1982) point out the following:

... it can be argued that there are other ways in which information acquisition may be disturbed. It can be argued that it is not motor movement per se that contributes to cognitive development, but the opportunity motor movement normally provides to link actions with consequences, to correct cause and effect, to develop schemata. Lack of interaction with the environment, not lack of movement, may more severely restrict cognitive development.

(Rostron and Sewell, 1982:43)

As pointed out previously, feedback is a crucial aspect of the learning process. Where a pupil receives feedback in respect of his actions, later performance can be modified. If action or control is restricted or if feedback is lacking, learning will be impaired. For an individual to have some kind of control over his environment in order to "model", "seek" or "discover" he must possess the means to interact with it. The learning disabled pupil is one who has been unable to control and get feedback from his environment which suggests that he is unable to extract and process meanings and implications from it.

The Hypothesis-testing theory of learning presumes that cognitive learning should be one of "modelling", "seeking" and "discovery". Where the possibilities have not existed for a child to do this, how can it be corrected by using a microcomputer? The answer would seem to be that one must create "models" for delivery via the microcomputer. These "models" can be in the form of a microcomputer environment or a "model" or representation of the physical environment.

As we are talking about the child's early basic skills development that precedes academic learning, it will be appropriate to pose the question as to whether children going through their early (Piagetian) development are capable of interacting with a microcomputer. Evidence

(Rostron and Sewell, 1982) from the United States has clearly demonstrated that children can engage in meaningful interactions with suitably designed technology at a very early age.

By creating models of the environment as suggested above, the pupils can gain a better idea of the real world and engage the software in such a way as to solve problems. Software of simulations as well as problem-solving techniques, would prove useful in this respect. The pupil has the chance to make gross errors without disastrous consequences. Simultaneously, the pupil can model himself on successful consequences. It is possible that interactions with such programmes where pupils have to "seek", "problem-solve" and be "creative" might create the basis for the development of more creative ideas at a later stage.

The LOGO programme of Seymour Papert is a well-known interactive environment which theorists suggest contribute to cognitive development. The LOGO computer language was born out of a particular educational philosophy. Those who follow this philosophy state that the micro-computer and the use of the LOGO language can offer a "learning environment" and self-expression to all pupils, but especially to handicapped pupils (Hagen, 1984). LOGO was created in 1968 as part of a National Science Foundation research project and since this date has been under constant development. Most of the work on LOGO has been carried out at the Massachusetts Institute of Technology (MIT) under Seymour Papert and his colleagues. In 1979, the MIT LOGO group began to adapt LOGO for use with microcomputers. The philosophy behind LOGO is that it allows pupils to interact with the microcomputer as a learning tool. The learning tool becomes a discovery tool. The idea is that the pupil is in charge of the environment and is able to "create" in self-directed ways rather than simply reacting to programmed tasks. Papert (1980) states:

The child, even at pre-school ages, is in control :
 The child programmes the computer. And in teaching
 the computer how to think, children embark on an
 exploration about how they themselves think. The
 experience can be heady : Thinking about thinking
 turns the child into an epistemologist, an experi-
 ence not even shared by most adults. (Papert, 1980:19)

Papert, who was heavily influenced by Piaget feels that the pupil should be placed in control of the computer, where he programmes the computer. This situation is ideal for the learning disabled pupil who doesn't have to be passive whilst receiving prescription, but who now has a chance to change the environment and discover aspects of the environment. The principles of LOGO are such that the pupil is able to discover certain principles about the larger world from the interaction with the more restricted environment. Rostron and Sewell (1982) state:

In this context the microcomputer provides the means of access to the defined environment. It thus becomes a tool for the handicapped child which can allow him or her to extend the range of experiences available. The "computer environments" reduce the complexity of the normal world, but can contain important principles which apply to the real world. (Rostron and Sewell, 1982:46)

What is suggested here is that the pupil becomes an active participant in the learning process. The child gains entrée to the microcomputer environment where he is able to explore it, thereby discovering its rules and principles.

Papert (1980) points out that the philosophy behind this process is one which states that the best learning takes place when the learner takes charge, and that the most appropriate kind of learning is the skill of learning itself.

The environment that is established when interacting with LOGO is the so-called "turtle-logic" mentioned earlier. The so-called "turtle" (Fig. 9) is a small triangular cursor which is controlled by the user.

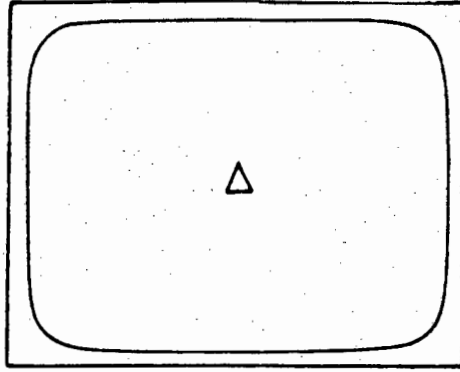


Fig. 9 LOGO : "Turtle"

The turtle can move in four ways : forward, back, right and left. Simply using these commands, the pupil will discover the enormous number of movements that he has under his control. It is not the intention here to give a LOGO lesson, but it will be useful to describe some of the more salient features of the language so as to make clear some of the text that follows. There are any number of references that can be used as a guide to LOGO. A particularly useful one is to be found in Using Microcomputers in Schools by Colin Terry (1981), and Mindstorms by Seymour Papert (1980).

Distance is controlled by adding a number to a directional command. (Fig. 10) In other words, Forward 60 moves the turtle sixty spaces, thus

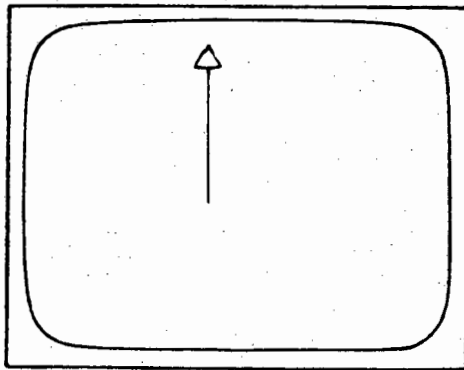


Fig. 10 LOGO : Controlling Distance

Turning right or left is controlled in the same manner with the entry of the degrees of the desired turn used as the command. Right 90

effects a turn of ninety degrees to the right and sets the turtle for the next distance move. (Fig. 11)

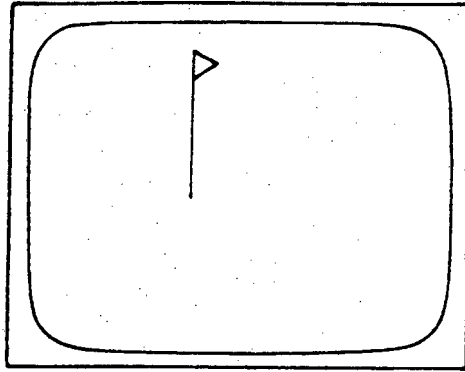


Fig. 11 LOGO : Direction

Forward 100 and Left 45 will execute the following and so on. (Fig. 12)

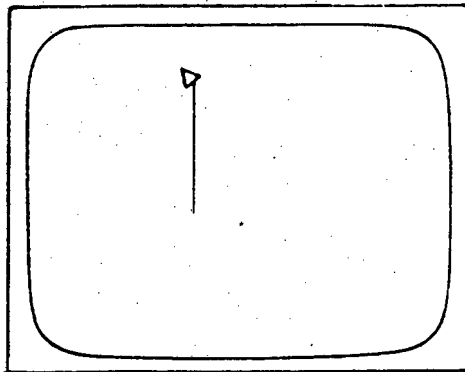


Fig. 12 LOGO : Direction

To make the computer draw a square, the pupil learns or discovers that the turtle must be turned the same amount, 90 degrees at each corner of the square and that all four sides must be of the same length. Eventually, the pupil should succeed in making the turtle draw a square. (Fig. 13)

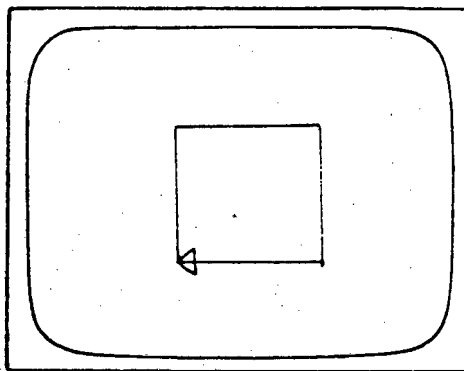


Fig. 13 LOGO : Drawing a Square

If the pupil wants the computer to remember how to draw the square he must describe a procedure for drawing a square, to the computer; in terms that the computer will understand.

The procedure might look like this:

```
TO SQUARE
```

```
Forward 100
```

```
Right 90
```

```
Forward 100
```

```
Right 90
```

```
Forward 100
```

```
Right 90
```

```
Forward 100
```

```
Right 90
```

```
END
```

or the programme can use a shortcut by typing the following:

```
TO SQUARE
```

```
Repeat 4 Forward 100 Right 90
```

```
END
```

The foregoing indicates that any series of commands can be written into a procedure. This can be a list of commands to create any geometric design by having the turtle leave a trail as it moves across the screen. Once defined as a procedure and given a name, the original design can be recalled by simply commanding the turtle to draw the named procedure. Seymour Papert elaborates on many aspects of LOGO in his book Mindstorms (1980). This book is often regarded as the handbook for those adherents of the so-called LOGO "movement".

(H S R C 1983)

It will be perceived from the foregoing that the discovery learning environment of LOGO contains numerous possibilities for pupils to investigate and give expression to certain ideas. The basic outline of

some of the principles of LOGO show that the pupil is in fact the teacher and is the one that tells the computer what to do. As Hagen (1984) points out: "There is no 'right' or 'wrong' in LOGO. There is just 'learning' when the turtle or procedure doesn't do what you want it to do".

Hagen (1984) suggests that LOGO has the ability to stimulate thought processes and logical sequencing. This is evident from the fact that as the pupil directs the turtle he starts to think about cause and effect as he works out the intended destination of each move and subsequent move of the turtle. Part of the learning process is achieved when the desired effect is not attained and the pupil has to attempt to rationalize where he went wrong. This is a classic example of acquiring the skills of "discovery" and "problem-solving".

The hypothesis-testing approach to teaching cognitive development has gone beyond a basic handicap or deficit to a sphere where the "special educational needs" of the child have been embraced; where he has been given the opportunity to control his environment, thus simultaneously being exposed to the principles of "seeking", "modelling", "inquiry", "discovery" and "creativity".

CHAPTER FOUR

4.0 AN OUTLINE AND DISCUSSION OF TWO SIGNIFICANT STUDIES

4.1 Introduction

Gleason (1984) suggests that computer research should move away from studies which attempt to establish the supremacy of computer-based instruction over teacher-based instruction. Instead, he states, attention should be given to finding ways of using the computer optimally in the educational process.

Gleason's argument is valid only if it can be established that computer interaction does enhance the learning process. A significant number of studies have, in fact, been undertaken which point to the potential benefit of the microcomputer in the learning process. Two studies which are referred to here were carried out in an attempt to establish the relative effectiveness of computerized over conventional remedial methods. In other words, to establish whether the microcomputer could be used effectively as a tool for learning disabled pupils.

These studies were undertaken approximately ten years apart. The first one was undertaken when computer applications were still in their infancy and the devices used were still rather unsophisticated. The latter study was undertaken when advances in microtechnology and computer software had progressed to the point where enthusiasm had been rekindled for further application of CAL.

Both studies proceeded from the premise that the more salient features of CAL are highly compatible with the major instructional and curricular principles recommended for learning disabled pupils!

Findings from these studies have given impetus to the rationale for utilizing microcomputers in a far wider sphere with learning disabled pupils.

4.2 STUDY NO 1

4.2.1 Introduction

Howard C Berthold and Robert H Sachs (1974) were prompted to undertake this study as they claimed that the task of developing specific methods for reducing school disability in the segment of the population labelled as emotionally disturbed, minimally brain damaged, hyperactive, etc. had not received the attention that it deserved. (Berthold and Sachs, 1974) Certain studies had been undertaken by Rubin, Simson and Betwee (1966) in which they identified principles currently being followed in special education programmes. Some of these more important characteristics were a graded series of academic tasks keyed to the individual, definite structure in the classroom, and a learning environment where academic stress was reduced as much as possible. Berthold and Sachs point out that the teaching machines in existence at the time incorporated most of these principles by providing clearly defined stimuli and expectations, active responses, immediate reinforcement and a gradual increase in the complexity of material. It was pointed out that the teaching machines had infinite patience, they minimized social stress and often reduced factors like teacher motivation and negative preconceptions about a pupil's ability. At the time of the study, a simplified programming language - MR COMPUTER - had been developed. (Stone and Lewis, 1972). This language enabled teachers without previous programming skills to master a computer language in a few hours. The language incorporated many techniques specifically designed for preparing and adapting individual lessons.

The purpose of the study, therefore, was to determine the effectiveness of computerized instruction with MR COMPUTER language for a group of special education pupils. Attention and performance were to be measured under conditions where the pupils worked with a teacher, a computer, or the two combined. (Berthold and Sachs, 1974).

4.2.2 Method

The subjects were six pupils who attended a school for so-called minimally brain damaged children. Five of the subjects were also labelled as emotionally disturbed. Their ages ranged from seven to eleven years with an average age of nine years. All the pupils had had experience on the teaching machine prior to the experiment.

Computerized instruction was delivered through a teletype machine connected to a time-sharing computer at the General Electric Research and Development Centre at Schenectady in New York.

Teachers selected particular materials such as multiplication and spelling which could be presented only during experimental sessions. The level and area of the material presented differed for each pupil based on the teacher's evaluation of the needs and capabilities of that particular pupil. The teachers were then requested to advance the complexity of the material in proportion to the progress made by the pupil.

Each of the pupils involved in the study was exposed to three treatments over a six-week period. During three randomly ordered two-week blocks, tutorials were presented by (a) a teacher, (b) a computer, and (c) a combination of teacher and computer. During a particular week, a pupil was presented with the relevant material on two consecutive days during a regularly scheduled thirty-minute afternoon period. The presentation was entirely by computer, entirely by a teacher in a one-to-one tutorial situation or by computer one day and teacher the following days.

The identical presentation method occurred the following week and thereafter the pupil was randomly assigned to one of the other methods for the next two weeks.

As the study was concerned with attention and performance, these concepts had to be defined and measured. Attention was defined as maintaining eye contact with the task. If observation of eye contact became difficult to monitor, appropriate head and body movements such

as sitting quietly and facing the task were used. Visible signs of involvement such as repeating a question or counting on the fingers were also regarded as attention. Observation was done by using a video camera, and in the teacher condition by an inconspicuous observer.

Reliability of the attention measure was checked by utilizing two people independently scoring ten sessions. The second person scoring a session had no knowledge of the experiment other than the definition of attention. The correlation between the two individuals' scores was $r = 0.99$ for the computer condition and for the teacher condition. Differences between scores never exceeded 2% of the total task time.

The performance aspect of the study was measured by improvement between a pre-test given prior to each session and a post-test at the conclusion of each session. The pre- and post-tests were identical.

4.2.3 Results of Study No 1

Table 2 shows the mean percentage of time that the pupils attended to the task, and the mean percentage improvement in performance after the task for each of the three conditions. A comparison of the attention means for the computer and teacher conditions by the randomization test for matched pairs approached significance ($p = 0.06$). Comparison between the other conditions revealed no significant differences ($p < 0.20$).

Table 2 : Percentage Average Attention and Performance Improvement Per Session for Three Instructional Conditions

<u>Condition</u>	<u>% Attention</u>	<u>% Improvement in performance</u>
Teacher	97.2	27.06
Computer	92.2	2.96
Combined	96.6	30.26

(Berthold and Sachs, 1974:123)

In terms of performance, the computer condition was significantly inferior to both the teacher ($p = 0.047$) and the combined ($p = 0.03$) conditions. No significant difference was found between the teacher and combined conditions ($p < 0.20$).

The Spearman rank correlation coefficients for the attention and performance scores were quite low for the teacher condition ($R = +0.08$) and the combined condition ($R = +0.17$). A significant negative correlation ($R = -0.815$; $t = 2.85, 4$, $p = 0.02$) was found for the computer condition.

Berthold and Sachs (1974) suggest that several reasons might account for the inferiority of the computer condition to the other conditions. A teacher is in a position to use more aids to illustrate a problem whilst he is also more adaptable than a programmed computer. It was also suggested that the full adaptability of the computer language used was not sufficiently utilized between sessions; possibly because the teachers were unaccustomed to depending upon the computer as much as was necessary under the computer condition.

Analysis of responses made during training sessions revealed that pupils proceeded through the material at an increasingly higher accuracy rate with successive exposures to the material programmed by the computer. Either advancement of the kind which occurred or a lack of advancement should have been a signal to adapt the material. In the light of this, the investigators suggested that future research should centre on maximizing the quality of the programmed material.

4.3 STUDY NO 2

4.3.1 Introduction

In the 1960's the dissemination of information in respect of computer use in education was, according to Atkinson (1968) based on speculation and assumption rather than scientifically researched experimental evidence. This was owing to the fact that not much research had been

undertaken in the field and certainly there was a paucity of empirical research assessing the effectiveness of computer-based learning over conventional methods.

McDermott and Watkins (1983) point out that investigations of CAL with learning disabled pupils were rare and it was to this end that they carried out their study. The study was designed to fill partially the hiatus that existed in this area of investigation by testing the effectiveness of well-designed mathematics and spelling CAL with learning disabled pupils at the elementary school level. Their study was carried out approximately a decade after that of Berthold and Sachs.

4.3.2 Method

Subjects participating in the study consisted of a group of 250 learning disabled pupils initially enrolled in elementary grades from 1 to 6 in a Southwestern school district in the U.S.A. All the pupils had been diagnosed as learning disabled by school psychologists, teachers and other educational specialists in accordance with State and Federal guidelines.

Eight remedial teachers from two of the district's seven elementary schools volunteered to conduct the CAL part of the project. Ninety-six learning disabled pupils attending the two schools in question were randomly assigned to either a mathematics CAL or spelling CAL experimental group. The district's remaining 154 learning disabled pupils were assigned to 19 other remedial teachers in the remaining five schools, and they served as a pool for a control condition receiving conventional remediation in mathematics and spelling.

Prior to implementing instructional activities, pupils' mathematical and spelling skills were evaluated using the arithmetic and spelling tests of the WRAT (Wide Range Achievement Test), and mathematical-computation and spelling subtests of the California Achievement Test. Pupils' levels of intellectual functioning were based on IQ's from the most recently administered WISC-R (with none dated earlier than one year preceding the instructional programme).

The experimental instruction was administered individually to pupils through multilevel-multifunctional microcomputer programmes covering the range from fundamental to advanced elementary mathematics and spelling skills. The programmes used were known as The Math Machine and The Spelling Machine. These were specially adapted for delivery through Apple II microcomputers. The teachers who had volunteered to conduct the CAL parts of the investigation were given thorough in-service training on the uses of microcomputer hardware and software, as well as possible applications of CAL with learning disabled pupils. (McDermott and Watkins, 1983) Besides this, the pupils approved IEP's (Individual Education Programmes) specified teachers' objectives in adopting computerized vs conventional mathematics or spelling instruction.

The experimental and control instructional programmes started in September 1980 and continued to May 1981. Records were kept of pupil time in CAL or conventional instruction. Time was measured in day units corresponding to the amount of instructional time devoted to mathematics or spelling during the average school day. The instructional programme was terminated for each pupil following an average of 139,02 days.

In respect of the data analysis, the experimental format consisted of a pre-test - post-test nonequivalent control group design in which the spelling CAL group functioned as a placebo contrast for the mathematics CAL group and vice versa for the mathematics CAL group and in which two types of criterion measures were taken: i.e., individually assessed achievement in mathematics and spelling and group-assessed achievement in those same subject areas. Data were analyzed in several ways including independent analysis of co-variance on post-test achievement raw scores and repeated-measure analysis of co-variance using standard-score achievement indices.

Finally t tests for correlated means were applied to evaluate overall pre-test - post-test achievement gains.

4.3.3 Results of Study No 2

Separate analyses were performed on the individually assessed Wide Range Achievement Test (WRAT) post-test, standard scores and California Achievement Test (CAT) post-test normal-curve equivalent scores. Each analysis comprised a two-way ANCOVA, with the first factor having three levels corresponding to the three methods of instruction, the second factor held as a within-students effect with two levels representing the mathematics and spelling criteria, respectively; and post-test scores co-varied for initial group differences in days of instruction, WISC-R Full Scale IQs, and pre-test criterion performance. Therefore, for each analysis, the desired effect (should the CAI procedures excel) would be reflected by a significant method of instruction x subject area (MI x SA) interaction, with Mathematics CAI pupils excelling on the mathematics criterion, Spelling CAI pupils on the spelling criterion, and both groups out-performing the Conventional Instruction Group.

Table 3 presents the ANCOVA summary analysis for WRAT achievement and Table 4 for CAT achievement. In neither case does a significant MI x SA interaction effect emerge, thus lending no support to the greater effectiveness of CAI over regular remedial instruction. For both individual and group methods of measuring achievement, a significant effect was discovered for the repeated measure. This simply indicates that standardized post-test scores for all pupils in aggregate were better in individually assessed spelling ($p < .05$) and group-assessed mathematics ($p < .01$).

McDermott and Watkins (1983) indicate post-test differences in WRAT achievement were attributed largely to initial pre-test differences where the pooled regression coefficient between pre-test and post-test scores was .72 ($p < .001$), as compared with regression coefficients for days of instruction ($r = .01$) and IQ ($r = .02$). This, it is pointed out, makes sense in view of the fact that the overall pre-test - post-test differences in WRAT achievement scores were minimal (M gain = 2.06 points) and statistically insignificant; it suggests that the item pool on the WRAT is perhaps too small and

differential difficulty between items too great to detect increments (across 1 academic year) within samples of learning-impaired pupils.

Table 3 : Multiple Co-variance Analysis of Individually-Assessed Achievement (WRAT) via Computerized and Conventional Instruction

Source	df	MS	F	
<u>Between students</u>				
Method of Instruction (MI)	2	29.61	.38	
Days of Instruction co-variate	1	17.58	.22	.01
IQ co-variate	1	10.94	.14	.01
Mathematics Pre-test co-variate	1	18105.74	229.30**	.77
All co-variates	3	6470.50	81.95**	
Students within groups	199	78.96		
<u>Within students</u>				
Subjects Area (SA)	1	188.25	5.89*	
MI x SA	2	55.15	1.73	
Spelling Pre-test co-variate	1	5182.09	162.27**	.66
Repeated measure x students within groups	201	31.93		

Note N = 205.

* $p < .05$

** $p < .001$

(McDermott and Watkins, 1983:85)

Table 4 : Multiple Co-variance Analysis of Group-Assessed Achievement (CAT) via Computerized and Conventional Instruction

Source	df	MS	F	
<u>Between students</u>				
Method of Instruction (MI)	2	96.40	.36	
Days of Instruction co-variate	1	3067.89	11.39*	.18
IQ co-variate	1	619.44	2.30	.05
Mathematics Pre-test co-variate	1	15957.44	59.22***	.49
All co-variates	3	7029.32	26.09	
Students within groups	199	269.44		
<u>Within students</u>				
Subject Area (SA)	1	1690.00	8.82**	
MI x SA	2	103.88	.54	
Spelling Pre-test co-variate	1	4241.18	22.13***	.38
Repeated measure x students within groups	201	191.62		

Note: N = 205.

* $p < .05$

** $p < .01$

*** $p < .001$.

(McDermott and Watkins, 1983:86)

In contrast, tests for overall pre-test - post-test differences in CAT performance revealed significant improvement for the combined instructional groups in mathematics (i.e. M gain = 7.31 points, $t = 6.14$, $df = 204$, $p < .001$) and spelling (M gain = 4.22 points, $t = 3.36$, $df = 204$, $p < .001$). Whereas the welter of CAT post-test differences are attributed primarily to pre-test performance (pooled $r = .44$, $p < .001$), the contribution of the days of instruction co-variate was significant as well ($r = .13$, $p < .01$), with IQ continuing to have no demonstrable effects ($r = .09$). This finding, in company with the more discernible CAT pre-test - post-test increments, may suggest the

greater sensitivity of the group-administered method to changes in achievement over the school year.

4.4 CONCLUSIONS

The two studies discussed here focussed specifically on learning disabled pupils interacting with microcomputers. Up to the time of these studies there had been, as pointed out, a relative paucity of research undertaken in respect of microcomputers with learning disabled pupils although Visonhaler and Bass (1972) had carried out ten independent studies with mainstream primary school pupils prior to the two studies discussed here. These studies were carried out with about 10 000 subjects within the curriculum areas of language arts and mathematics. The results indicated a substantial advantage for CAL augmentation of traditional classroom instruction, where standardized achievement tests are used as the criteria for educational performance. In the studies carried out, Visonhaler and Bass indicate that generally the CAL groups showed performance gains of one to eight months over groups receiving traditional instruction.

The studies of Visonhaler and Bass involved the drill and practice mode of delivery. Drill and practice is one of the most popular modes of delivery via microcomputers and much spelling and mathematics software, in particular, is of this mode. The writer is not aware of the nature of the mode of delivery of the software in the Berthold and Sachs study, but the software used by McDermott and Watkins (viz. Spelling Machine and Math Machine) is predominantly of a drill and practice nature.

In the case of the studies of Visonhaler and Bass, the effectiveness of CAL over traditional instruction in the curriculum areas of language and mathematics seems to be a reasonably well-established fact. The studies of Visonhaler and Bass (1972), Berthold and Sachs (1974) and McDermott and Watkins (1983) seem to suggest that with primary school pupils - both conventional and remedial - there is

little reason to doubt that CAL plus conventional instruction is usually more effective than conventional instructional alone in developing skills.

The investigations of Berthold and Sachs (1974) indicated that a combined teacher/computer learning situation showed promise of success. The study of McDermott and Watkins (1983) suggested that both computer and teacher instructional methods were beneficial albeit of an equivalent nature. The over-riding conclusion that can be reached by examining these two studies is that it is possible that - at the very least - combinations of computerized and conventional remedial instruction may work with learning disabled pupils and that the success of these applications will vary depending on the severity of the learning disabilities and the differential styles of learning.

McDermott and Watkins (1983) suggest that, assuming similar degrees of effectiveness and efficiency, it might be reasonable to assign pupils to CAL programmes whenever it appears that such an application will diminish the motivational deficits and resistance which is often synonymous with learning disabled pupils, and to recommend special teacher-instructed programmes whenever affiliative needs and social conditioning are considered to be important aspects of the learning process.

These early studies, by proving the potential effectiveness of the microcomputer as a remedial learning aid, have paved the way for further research into applications. Many experts in remedial education (Gerheart, 1976; Wallace and McLaughlin, 1979; Wiederholt, Hammil and Brown, 1979; Vitello and Bruce, 1977; Caldwell and Rizza, 1979 and Watkins, 1981,) state that into the 1980's greater energy should be directed to research in the sphere of microcomputer use with learning disabled pupils for the simple reason that many of the attributes of CAL closely parallel the principles of remedial education.

CHAPTER FIVE

5.0 ILLUSTRATIVE STUDIES : AN OUTLINE AND DISCUSSION

5.1 Introduction

This chapter outlines and discusses two cases where learning disabled pupils were exposed to commercially available software as a prescription in order to remediate deficits and inculcate new behaviours.

The cases in question involved one where a group of approximately 40 pupils interacted with a spelling programme, COMPU-SPELL, and another case where groups of children interacted with the LOGO programme.

The two cases examined here do not constitute a research study. They were carried out rather for the recording of observations than obtaining concrete evidence of, for example, the ascendancy of the micro-computer methods over conventional teaching methods. The studies in question occurred at the Sea Point Primary School, Sea Point, South Africa.

5.2 CASE 1 : A SPELLING PROGRAMME

5.2.1 Background: Spelling and Spelling Disability

Before attempting to remediate a deficit in spelling, one must first decide what is meant by (a) spelling, and (b) a spelling disability. Like all concepts, spelling has been defined in many ways. Todd (1982) suggests the following "working definition" of spelling: "to name or set down from memory, in the correct order, the letters of a word". Lerner (1981) states that spelling is the one curriculum area in which neither creativity nor divergent thinking is encouraged; only one pattern or arrangement of letters can be accepted as correct.

Peters (1967) raises the questions as to what are the main causes of spelling failure, and what makes a person a good speller. It is suggested that some pupils cannot spell because of some psychological defect whilst certain pupils cannot spell because they lack the motivation to do so. Peters suggests that many pupils are good spellers because they have had a favourable environment in which to acquire the skill. Peters (1967) further suggests that there are certain factors which can be classified as determinants of competence in spelling. It is pointed out that although the classification can be considered as arbitrary, the main factors that are relevant can be classified as being those connected with:

- Physical and Psychological Abilities

- (i) Motor
- (ii) sensation
- (iii) perception
- (iv) imagery

- Educational Experiences

- (i) Opportunity to write creatively
- (ii) early perceptual experiences
- (iii) spelling teaching

- Motivational

- (i) A casual attitude generally
- (ii) self image

(Peters, 1967:18-33)

Peters (1970) states, therefore, that the skill of spelling is determined by a network of subskills and attributes overlaid by the pupils' self-image, all of which are not only susceptible but crucially affected by teacher behaviour by the time the pupil leaves pre-primary and kindergarten (Std. 1). By the time that the pupil leaves senior primary school (Std. 5) his control of the spelling system is totally affected and influenced by the teacher or teachers with whom he has worked. Peters (1970) in her research suggests that teacher variables are very important and that there is evidence as to what, in the teacher, is conducive to spelling progress. These can be enumerated briefly as follows:

- (a) Teachers who are consistent in attitude, however oriented, who are systematic and rational in their teaching achieve spelling

progress even, and especially if the pupils begin at a very low level of spelling ability

- (b) Teachers, whose pupils learn to spell, do teach lists, but these lists are derived from pupils' writing needs, from words "asked for" in the course of pupils' own writing and from lists prepared by the teacher in relation to words the pupils "ask for"; not from printed lists which would seem to have a detrimental effect on children's spelling progress
- (c) The amount of time spent on list-learning is important
- (d) It is not in fact "instruction" which is significant, but for example, how pupils are expected to "do corrections"....
- (e) Again "trying out" of words before asking or looking up, is conducive to spelling progress, probably because this activity reflects an attitude to autonomy in the pupil's learning to spell engendered by the teacher.

Having attempted to outline some of the determinants of spelling competence it is now appropriate to discuss aspects of spelling disability.

Torbe (1977) suggests that there are two main reasons for not being able to spell. These he lists as:

- Weak visual memory
 - Weak auditory analysis
- (Torbe, 1977:5)

Torbe maintains that the most common reason is weak visual memory. He states that a poor speller with weak visual memory (a) has a fairly clear idea of which symbol represents which sound, (b) doesn't remember how the word should look, and becomes confused when he tries to write it down, and (c) is not necessarily a poor reader. His spelling errors will be recognizable as the intended word. A poor speller with weak auditory analysis, on the other hand, will display

spelling errors that may be unrecognizable as the intended word. A poor speller with weak auditory analysis, on the other hand, will display spelling errors that may be unrecognizable as the intended word. He will display some of the following characteristics: (a) He can't say which letter symbols represent which sound. (b) He can't hear what the constituent sounds of a word are. (c) He makes random and arbitrary guesses. (d) He is probably also a poor reader. (Torbe, 1977)

Lerner (1981) adds that there are, therefore, many subskills and abilities demanded in the act of spelling. Pupils must be able to read the word as well as being knowledgeable and skilful in certain relationships of phonics and structural analysis. Pupils must be able to apply appropriate phonic generalizations and must be able to visualize the appearance of the word. Finally, pupils should also possess the motor co-ordination to be able to write the word. Lerner (1981) states that difficulties in spelling may be due to a deficit in any or a combination of the above skills.

It is now appropriate to consider ways of teaching or remediating pupils with spelling difficulties.

Westwood (1981) suggests that remedial assistance with spelling will vary according to individual weaknesses, but that three general principles should be considered:

- The pupil must be interested in his own progress and must feel that he is improving
- The aim of the teaching sessions should be to develop useful "word study" techniques in the child : the habit of careful looking. From these techniques it is hoped he will be able generally to understand word structure and grasp that sequences of letters occur frequently together to represent units within words. Though many words are learned incidentally, proficiency will be improved if habits of word-study are taught.

- With very weak spellers appeal must be made to as many senses as possible. A word must be seen, listened to and pronounced correctly for the sound characteristics, and written for the "feel" of it.

(Westwood, 1981:132)

Lerner (1981) describes a number of activities which can be employed in the teaching and remediating of spelling. Numerous educationists (Lerner 1981, Westwood 1981, Torbe 1977, Peters 1967, Todd 1982) subscribe to these activities, and especially those of a multi-sensory nature when it comes to remediating spelling deficits. Briefly two methods devised by Fitzgerald (1955) and Fernald (1943) are enumerated as forming the cornerstone of multisensory spelling remediation programmes in existence today.

A. Multisensory Methods in Spelling: The following five steps are suggested by Fitzgerald (1955) as a multisensory approach that utilizes the visual, auditory, kinesthetic and tactile modalities.

- (a) Meaning and pronunciation. Have the pupil look at the word, pronounce it correctly, and use it in a sentence.
- (b) Imagery. Ask the pupil to "see" the word and say the word. Have the child say each syllable of the word, say the word syllable by syllable, spell the word orally, and then trace the word in the air, or over the word itself, with a finger.
- (c) Recall. Ask the pupil to look at the word and then close his eyes and see the word in his mind's eye. Have him spell the word orally. Ask him to open his eyes to see if he was correct.
- (d) Writing the word. The pupil writes the word correct from memory, checks the spelling against the original to see if it was correct, and then checks the writing, too, to make sure every letter is legible.
- (e) Mastery. The pupil covers the word and writes it. If he is correct, he should cover and write it twice more.

B. The Fernald Method. This method, evolved by Fernald (1943) is a multisensory approach to teaching, reading and writing as well as spelling.

- (a) The pupil is told that he is going to learn words in a new way that has proved to be very successful. He is encouraged to select a word that he wishes to learn.
- (b) The teacher writes that word on a piece of paper, as the child watches and the teacher says the word.
- (c) The pupil traces the word, saying it several times, then writes the word on a separate piece of paper while saying it.
- (d) The word is then written from memory without looking at the original copy. If it is incorrect, the tracing and saying steps are repeated.
- (e) At later stages the tracing method is no longer needed. Now the pupil learns a word by looking as the teacher writes it, saying it, and writing it. At a still later stage, the pupil can learn by only looking at a word in print and writing it, and finally, by merely looking at it.

(Lerner, 1976:265)

5.2.2 Introduction to Study

Some of the more sophisticated commercially available CAL spelling programmes available today attempt to incorporate some of the aforementioned principles in their delivery. One such programme COMPU-SPELL - published by Edu-Ware services (1982) used as a remedial aid to spelling, incorporates a number of the principles described above. The publishers describe the programme as "an instructional course that uses perceptual principles and positive reinforcement to teach spelling". (McCarthy 1982)

COMPU-SPELL is a technically sophisticated computer managed sequence of spelling drills containing thousands of appropriate words for pupils at varying levels of spelling competence. The programme is designed to teach spelling through memorization and positive reinforcement. Pupils are presented with a list of spelling words which may be

part of sentences or given separately. Initially, the pupil is presented with a "page" containing a number of sentences (Fig. 14)

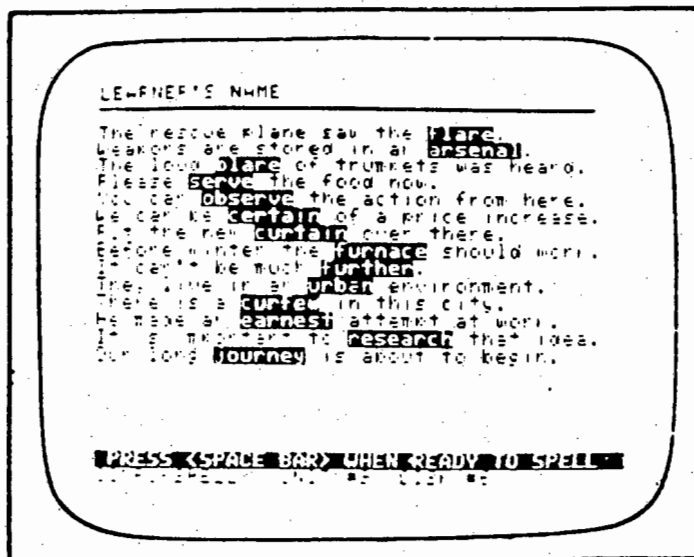


Fig. 14 "Page" Containing Sentences

The box around a word represents "inverse" (black-on-white) printing. When the space bar is pressed, the word disappears and the inverse block remains. The task of the pupil is to type the first word "flare" in the blank block. (Fig. 15)

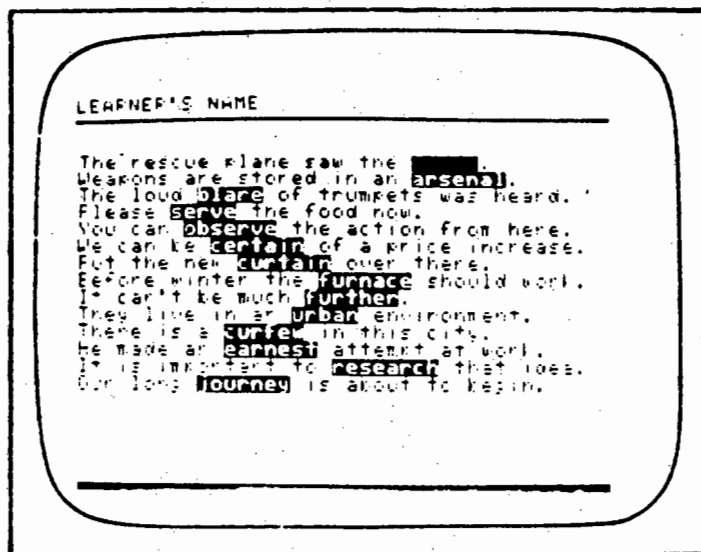


Fig. 15 Typing in the Words

average there were still many pupils who experienced spelling difficulties and that it was this problem that created the rationale for pursuing the programme/study. Concurrently with the micro-based remedial programme, it was decided to carry out an informal study to attempt to establish whether the pupils exposed to the computer programme advanced at a rate greater than those exposed to spelling tuition by conventional means.

5.2.3 Method

The programme/study was carried out under the supervision of the principal teacher assisted by the resource room teacher. Classroom teachers collaborated with the principal teacher in establishing which pupils would be selected for the microcomputer part of the exercise. The principal teacher was responsible for controlling and collating the data. The resource room teacher supervised and assisted the pupils with the microcomputer interaction where this was deemed necessary.

The school went about selecting the pupils for the programme by comparing scores of standardized Human Sciences Research Council (H S R C) spelling tests with pupils' statistical data in the following areas: (a) general ability (H S R C IQ tests), (b) ability in English (H S R C Scholastic tests), and (c) school marks. If spelling was lower by at least twenty percentile rankings in each of these comparisons, the pupil was regarded as requiring help with spelling. Using this method of selection, 41 pupils in Standards Two, Three, Four and Five were identified as needing remedial spelling. By his own admission, Waker (1984) states that ... "the method is rather crude in that it does not help to identify underlying aetiology, and can therefore lead to true remediation only by chance."

The pupils interacting with the COMPU-SPELL programme came from eight different classes which meant that they had been exposed to eight different methods of spelling instruction. Although teachers employed variations of methods to teach spelling depending on the individual needs of pupils, most relied on basic "phonic" methods.

Before the pupils were exposed to the computer programme they were given exposure to the microcomputer to establish that they knew how to use it without teacher assistance. The programmes themselves were modified as far as possible to eradicate American spelling and to adapt the content to match the experience of South African pupils.

When the pupil logged in at the microcomputer he was presented with his lesson of ten related spelling words embedded in appropriate sentences. There were 70 lessons of this nature for each of the Standards Two to Five. The programme took each pupil through the lesson twice. As indicated earlier, the pupil was presented with a post-test at the end of his session after which he was given the choice of logging off or going on to the next lesson. The programme was designed to insist upon a 100% correct answer but it was later adapted to accept 80%. Waker (1984) explains that this was done in order to allow for typing errors. Words which proved to be a stumbling block were repeated both immediately after each lesson and then in subsequent lessons until completely mastered.

The programme included a management mode which allowed the class teachers to follow the progress of the pupils. Every week the class teachers were given a printout of the number of exercises done by the pupil, and his score.

5.2.4 Results

Waker (1984) points out that even though no method of pre-selecting those who would respond to this mode of learning was available, the 35 pupils left in the test group progressed at more than double the rate of the rest of the pupils during the six months of the controlled experiment (13,5 months progress for the test group in contrast to 6,4 months progress for the control group).

5.3 CASE 2 : LOGO

5.3.1 Introduction to Study

In 1983 the H S R C Education Research Programme published its findings regarding the use of the computer in education and training. Part 5 of the full sets of reports concerned strategies for the introduction of computer awareness and computer literacy. In respect of computer literacy, the committee researching the issue stated that it did not wish to prescribe a rigidly defined introductory age or a single approach to the teaching of these topics, but added that one approach to the question of computer literacy is the so-called "turtle-logic" of which LOGO is the best developed of these approaches. The philosophy, educational objectives and workings of LOGO have been discussed elsewhere in this study and will, therefore, not be elaborated upon here, suffice to say that Sea Point Primary School decided to embrace the recommendation of the H S R C Education Research Programme that an approach to computer awareness and literacy could be achieved by introducing the pupils to LOGO.

As pointed out elsewhere in this study, Papert feels that the child should be placed in control of the microcomputer where he programmes the microcomputer. Interacting with LOGO enables the child to do just that. It was with this in mind that Sea Point Primary School introduced LOGO to pupils in the senior primary classes. An additional consideration that was borne in mind when introducing LOGO was the fact that it is also suitable for use with learning disabled pupils. All pupils could therefore be introduced to the programme as equal partners with all of them being in a position to derive benefit from "scratch".

As suggested, LOGO is potentially an ideal environment with which learning disabled pupils can interact. The learning disabled child is not passive when interacting with LOGO but now has an opportunity to act on an environment. The principles of LOGO are such that the pupil is able to discover certain principles about the larger world from the interaction with a more restricted environment.

5.3.2 Method

The LOGO programme was delivered through Apple II microcomputers. Initially the role of the classroom teachers was minimal in this exercise; they were simply required to divide the class into two groups based on IQ scores. This was done so that each pupil would have a computer terminal; and to pre-empt the possibility that pupils who might be very slow at grasping a concept would hold up the rest of the group. This division also contained the best chance of grouping possible learning disabled and slow-learning pupils together. No specific note was taken as to who the learning disabled pupils in the class were. The LOGO lessons were carried out entirely by the computer teacher who was not aware of individual differences of pupils. The intention was to introduce all the pupils to something that none had ever been exposed to before. It was for this reason that individual differences or disabilities were not a consideration at this stage. Within their groups, pupils were sometimes randomly assigned to share a terminal with others if enough terminals were not available.

The first lesson consisted of the teacher explaining some concepts and strategies. The pupils had to know something about distance and directionality. This was done by using "Bigtrack", a battery operated tank-like toy with a keyboard on top. Pupils brought a notebook and pencil to the lessons and had to design a "route" for "Bigtrack" to take across the floor of the computer room. They could draw the plan according to their instructions. After "keying" in the instructions they were fascinated to see whether "Bigtrack" moved in the direction according to their pre-designed plan. The learning disabled pupils who had spatial and directionality problems made numerous errors but with repeated efforts soon displayed increased fluency in this area.

After two sessions of working with "Bigtrack" pupils moved to "hands-on" experience. The computer teacher conceded that she had to apply certain classroom management techniques whilst teaching LOGO to ensure that pupils grasped what they had to do. Much "teacher-talking-time" was involved in the initial stages of instructing the pupils at the

consoles. In order to accomplish this as best as possible the pupils turned their backs on the microcomputers and faced the teacher who stood at the front of the class, at the chalk board in order to use it as an aid. The microcomputers were placed around the perimeter of the room. The intention of having the pupils turn away from the microcomputers was intended to eliminate distractibility amongst all the pupils but especially the learning disabled ones. The computer teacher reported that "without exception" all the pupils were "raring to go".

It was explained to the pupils that there were abbreviations to certain directional instructions. These were printed on posters for the benefit of any learning disabled pupils in order that they might not forget them. They were posted on the walls of the computer room.

The LOGO sessions, over a three-month period proceeded with pupils being introduced to new strategies and concepts every week. The computer teacher attempted to provide less assistance every session as the pupils became more familiar with the programme. The intention was for the pupils to advance as much as possible on their own. When pupils made errors, the teacher would not simply tell them where they went wrong but would request that they "de-bug" the error themselves. It was explained that errors should not be seen as such, but rather as problems to be solved.

5.3.3 Results

The writer observed his class only. This was done by visiting the computer room as well as discreetly observing behaviours in the classroom. Because of the nature of the exercise, there were obviously no recordable statistics. No pupils experienced a "blank" whilst working with LOGO. During the initial introductory months, the pupils were extremely enthusiastic about attending these lessons. Classroom teachers reported pupils coming up to show them their notebooks where they had planned graphics; and enthusiastically displayed print-outs of their finished articles. Classroom teachers who visited

the computer room were amazed to find that so-called "introverted" or learning disabled pupils entered into the business of LOGO with much gusto. Such pupils were often seen explaining to, or assisting so-called more able pupils and spoke knowledgeably and confidently about what they were doing. Teachers reported that this confidence was very often carried over to the regular classroom. Many learning disabled pupils were able to operate at the same level of non learning disabled pupils in the computer room. They were just as aware and literate as their peers. Their interaction with LOGO appeared to advance their motivation and contribute towards an enhanced self-image. Learning disabled pupils loved being asked to explain aspects of LOGO or microcomputers to teachers, some who in fact had less experience with computers than the pupils themselves!

A point which Atkinson (1984) makes and which is appropriate to mention here regards the questions of impulsive behaviour. He points out that although little empirical research has been done on the subject, observations and case studies have indicated a decline in pupils' impulsive behaviour while working with a microcomputer and very often this decline in disruptive behaviour is carried back to the regular classroom. In respect of the LOGO study, observation revealed that mixed success was attained in this sphere. Two pupils both of whom had been diagnosed as learning disabled and who were regarded as highly hyperkinetic and distractible were included in groups observed by the writer. After two sessions in the computer room one, a boy, was excluded from the sessions because of his lack of concentration and disruptive behaviour. The other pupil, a girl, of serious nature, engaged LOGO enthusiastically. The girl in question, who was particularly weak in maths, was not deterred by the mathematical aspects of LOGO and became quite proficient at it. There were minimal signs of hyperkineses and distractibility although she worked fairly slowly thinking carefully before keying the information into the microcomputer. She did not experience any difficulty regarding angles and directionality and appeared to follow completely the progress of the lesson.

Back in the classroom she displayed a very definite improvement in

powers of concentration and the ability to focus on aspects of the lessons. This was particularly evident in mathematics lessons where there was even a slight improvement in her performance.

5.4 Conclusions

COMPU-SPELL is an example of a drill and practice programme. Pupils with a spelling deficit cannot learn via this mode alone. Although it can be argued that in spelling there is only one pattern or arrangement of letters that can be accepted as correct, there are numerous ways in which spelling can be taught. The pupils preferred learning style must be borne in mind. There are also certain spelling rules that need to be made known. A drill and practice programme cannot address these kinds of problems.

Although a programme such as COMPU-SPELL does not offer a tutorial mode, the drill and practice mode does offer certain positive advantages. As mentioned earlier, it emphasizes imagery and visual sequential memory; two important skills required in the acquisition of spelling proficiency.

Bearing in mind that there are few if any spelling programmes available that could meet the specific needs of all pupils with a spelling deficit, the authors of COMPU-SPELL have certainly attempted to devise a programme that is based on accepted educational principles and which can at least meet certain requirements of pupils with a deficit in this area.

McCarthy (1982) suggests that the value of a programme such as COMPU-SPELL could lie chiefly in its ability to teach particular types of words, such as words that are basically learned visually. This can be undertaken with pupils who are having trouble with such words. It is also of value to be used as a drill to teach irregular words. He concludes that compared with complex language-arts subjects like reading comprehension or writing, spelling is a relatively simple learning process to analyze and to teach and that microcomputers could facilitate greatly in this domain of learning.

Behrman (1984) suggests that a primary feature of LOGO is that it provides a learner-driven activity that capitalizes on previous learning such as concepts like direction, angles and distance. He maintains that pupils can capitalize on and refine their spatial concepts and co-ordinate various types of tactile, kinesthetic, visual and motor information into the control of the turtle.

Teachers are able to alter the level of complexity of LOGO by introducing activities that are commensurate with a particular pupil's ability. Simpler versions of LOGO can adapt for physical or cognitive abilities, and more complex activities can be given to "brighter" children.

LOGO presents a long-term learning environment according to Atkinson (1984). He suggests that pupils with learning disabilities should be encouraged to work on projects in which they build their own "drill machines". Often such learning disabled pupils require assistance with multiplication facts or spelling words or vocabulary development. Such pupils, he suggests, can plan, develop and create drill programmes with LOGO that are specifically designed to help them in their personal weak areas.

Behrman (1984) suggests that using a programming language like LOGO will not provide all the answers to problem-solving in education nor will it be the "panacea" as Atkinson (1984) points out to either learning assistance problems, or to computer literacy in general. However, it must be considered as an extra tool for the learning disabled pupil. It may reveal hidden strengths in pupils such as a strong ability to utilize the spatial code of learning (Behrman, 1984), and can provide teachers with additional insights into learning styles of the children with whom they work.

In respect of the point made by Atkinson (1984) regarding distractibility and impulsive behaviour, it can be argued that success gained in these areas is due to the "sense of control" that pupils acquire as they learn to "programme" a microcomputer. By being able to inculcate a

"sense of control" together with the ability to control pupil's impulsive behaviour, success is being achieved in the area of deficit that is one of the most difficult to remediate within the school setting.

Weir, Russell and Valente (1982) suggest that the impact of LOGO is threefold for pupils who are not being successful at school:

- It provides the possibility of experiencing success and demonstrating expertise.
- It allows further development of the preferred spatial mode.
- It is a diagnostic tool that suggests to teachers new ways of creating more appropriate curriculum by harnessing spatial skills.

(Weir, Russell and Valente, 1982:342)

Hagen (1984) endorses these views in the following ways:

With LOGO you break a problem down into the component elements with which your experience will allow you to work, and then you use these elements to procedurally discover new knowledge. In essence, you start with the known and move to the unknown... Each child will explore LOGO and find something new because it is not a lesson to be taught, it is a discovery of the unknown. Every child will receive something unique from the LOGO environment because it is the child's own environment created and taught to the microcomputer by the child.

(Hagen, 1984:69)

As pointed out at the beginning of the chapter, this section was not intended to be a sophisticated empirical study designed to prove the ascendancy of microcomputer methods over conventional methods of tuition. The idea here was an attempt to put into practice in an informal manner, theories postulated by educationists in respect of microcomputer use with learning disabled pupils. By carrying out the studies it was hoped that evidence would be obtained regarding the benefit of microcomputer use in areas where it had been claimed they could be of use. At the time of the studies relatively few identifiable, tried and tested remedial programmes were available. It was for

this reason that these tentative steps were taken to adapt regular commercially available programmes for remedial use.

In both cases the writer feels that sufficient evidence of potential benefit was gained from the exercise to warrant a continuation of applications. These applications could be extended to other curriculum areas. By indicating how a commercially available programme such as COMPU-SPELL can be adapted for remedial use, the way is open to use other acceptable programmes in a similar manner. However, once truly tried and tested remedial software becomes available the prognosis for the successful harnessing of the microcomputer in remedial education will be even more encouraging.

CHAPTER SIX

6.0 MICROCOMPUTERS AND REMEDIAL EDUCATION: A Survey of Applications and Attitudes

In the light of developments in the United Kingdom and the United States it was considered appropriate to undertake a survey of applications and teacher attitudes within South Africa in general, and the Cape Peninsula in particular.

The survey was undertaken in the Cape Peninsula as the writer is a teacher based there. In the Cape Peninsula there is a fairly dense concentration of schools of all population groups and it was felt that feedback from a selection of schools catering for various population and socio-economic groups would give a significant indication of the state of affairs as it relates to microcomputer use in remedial education.

From the outset it must be pointed out, that permission to conduct the research was granted by the provincial educational authorities with the undertaking that no school, clinic, higher educational institution or teacher be identified. This undertaking has been honoured.

6.1 Introduction to the Survey

Owing to the relatively dense concentration of schools in the Cape Peninsula and their accessibility, it was decided to undertake a survey in order to establish the extent to which they were employing the microcomputer in remedial education. It was decided that only primary schools would be surveyed as much intervention takes place at kindergarten (substandards A - B) whilst pupils entering high school are often considered to be beyond assistance. Most remedial education is currently aimed at the primary school pupil.

Schools in the Cape Peninsula have an established infrastructure for offering remedial assistance. Although there are not enough teachers to meet the demand, all three of the major universities offer remedial teacher training courses and the teachers qualifying serve in schools as

full-time or itinerant remedial teachers. Conventional teachers who additionally qualify as remedial teachers either take up full-time or itinerant positions or they return to conventional teaching, helping out where needed or becoming involved in T.A.T. groups. Itinerant remedial teachers are attached to school clinics and together with the heads of clinics - usually an educational psychologist - they are responsible for diagnosis, programme design and prescription in schools not served by full-time remedial teachers. Schools with no full-time or itinerant remedial teacher have recourse to the nearest school clinic. University child guidance clinics also play a similar role here.

The position, therefore, is that despite the shortage of remedial teachers, a fairly structured system of remedial education is available in the Cape Peninsula, from the training of teachers down to the actual remedial teaching in schools. Certain schools have more than one remedial teacher; whilst the success of a remedial department at a school often depends on the ability of the school to make available to remedial teachers a congenial climate in which to work as well as providing sufficient of the necessary resources.

The aim of the survey was to establish contact with those individuals and institutions involved in remedial education and attempt to establish the extent to which they might be using the microcomputer as a resource. Attitudes to the use of the microcomputer in remedial education were also gauged.

It will be appropriate to mention at this point that there is as yet no national or provincial policy set out by the educational authorities in respect of microcomputer use in remedial education.

6.2 Method

Having established that there was no national or provincial educational policy in respect of microcomputer use in remedial education, it was decided that schools and other educational institutions should be surveyed to establish what initiative they had taken on their own.

The following institutions were approached:

6.2.1 Institutions Surveyed

- (a) Universities in the Cape Peninsula/Western Cape
- (b) Teacher Training Colleges
- (c) School Clinics
- (d) Teachers' Centres
- (e) Specialized Schools for Specifically Learning Disabled : Nationally
- (f) Specialized Schools (Cerebral Palsy) : Cape Peninsula
- (g) Primary Schools : Cape Peninsula

Except for category(e) where the schools were controlled by the House of Assembly Administration (White), the other categories incorporated all population groups. It will be appropriate to point out at this stage that it was decided not to categorize the data on racial lines. This was deemed both unnecessary and inappropriate. (To indicate this point, it can be mentioned in passing, that in certain areas of endeavour, so-called Coloured schools, contrary to pre-conceived expectations, had in fact made far greater advances than their White counterparts.)

The collection of the data required was undertaken via questionnaires, personal interviews at various institutions, telephonic interviews and correspondence.

6.2.2 Type of Survey

(a) Universities

Within the context of educational institutions, it was thought that universities might be leading the way in introducing future remedial teachers to a new technology. In this case, the technology in question was the computer. A letter was sent to each of the three universities in the Cape Peninsula/Western Cape requesting information in respect of microcomputer content in courses dealing with educational aids.

(Appendix 2)

.... I should appreciate it if you could advise me as to whether you have included in your curriculum for trainee remedial teachers an elective dealing with the use of microcomputers as a diagnostic, prescriptive or management instrument in the teaching of specifically learning disabled pupils.

Further I should appreciate it if you would advise me of any other work you might be doing in this field... (Extract from letter).

(b) Teacher Training Colleges

An identical letter was sent to three Teacher Training Colleges in the Cape Peninsula/Western Cape. Students attending Training Colleges for a three or four year course are offered an elective in remedial education.

(c) School Clinics

School Clinics co-ordinate the work of itinerant remedial teachers in the field as well as offering services themselves in the area of diagnosis, programme design and prescription. Clinics are headed by an educational psychologist.

Clinics were surveyed as it was thought that the heads, as instructional leaders, might be involved in introducing microcomputers at their clinics as well as guiding remedial teachers attached to their clinics in the use thereof.

All the school clinics in the Cape Peninsula were surveyed via a letter. (Appendix 3)

.... I should appreciate it if you could inform me briefly of the extent, if any, of microcomputer applications at your clinic, particularly in diagnosing, prescribing and managing pupils with specific learning disabilities.

Should you be utilizing microcomputers in any of the above spheres, I should appreciate it if you would indicate whether I might observe the work being done.... (Extract from letter)

(d) Teachers' Centres

Two Teachers' Centres in the Cape Peninsula were surveyed. This was done per telephonic interview. One centre suggested that a departmental audio-visual centre nearby be approached. An interview with the Head was arranged.

Teachers' Centres exist to offer courses as well as to introduce new resources to in-service teachers. As courses are often offered in the use of educational technology and new resources it was thought that moves might have been taken to introduce the microcomputer to remedial teachers.

(e) Specialized Schools for Specifically Learning Disabled : Nationally

The schools surveyed here are the three schools categorized as catering for the neurally handicapped in general, but for the specifically learning disabled in particular. The schools are controlled by the National educational authorities (as opposed to the provincial departments of education). The schools in question are those catering for white pupils from Substandard A up to senior school level. One school is the Cape, another in the Transvaal and a third in Natal. As these schools are categorized as catering for the specifically learning disabled it was assumed that they might be at the forefront of new technological advances, especially where they can be of assistance to the handicapped pupils. It was for this reason that they were surveyed. The principals were contacted per telephone and letter (Appendix 4) in order to establish the extent of microcomputer applications at the schools.

(f) Specialized Schools (Cerebral Palsy) : Cape Peninsula

Two schools catering for cerebral palsy pupils were contacted. It was known in advance that both schools were using the microcomputer. Being cerebral palsy schools, numerous applications concerned physically handicapped pupils. The idea was to establish the extent to which those pupils who were categorized as specifically learning disabled at these schools were interacting with the microcomputer. The schools were contacted

telephonically in order to interview the individuals in charge of the computer departments. A visit was undertaken to one in order to observe the applications.

(g) Primary Schools

Ninety-five primary schools were surveyed. A questionnaire was sent to each school with a covering letter (Appendix 5) and a self-addressed envelope. The idea was to gather information in respect of micro-computer applications as well as the potential for future involvement. Teacher attitudes were also sought. Two methods were used for selecting schools to be surveyed. Schools that were definitely known to have microcomputers were sent questionnaires whilst the balance were randomly selected from address lists. It was considered important to survey schools without microcomputers in order to gauge teacher attitudes to the technology as well as to establish the prognosis for the future introduction of microcomputers. Primary schools controlled by the House of Assembly and House of Representatives Administrations were surveyed. It was established in advance that no schools under the House of Delegates Administration were using microcomputers for remedial purposes, whilst schools falling under the Department of Education and Training (Black) were not surveyed owing to logistical difficulties and the assumption that there were more pressing needs at these schools.

6.3 Results

(a) Universities

All three of the universities responded to the letters. Their replies were succinct and without qualification. They stated that they did not make any use of the microcomputer in remedial education. No elective was offered at any of the universities in which trainee remedial teachers were introduced to microcomputer use in remedial education.

(b) Teacher Training Colleges

The teacher training colleges that responded to the inquiry indicated that no courses were offered to trainee teachers in microcomputer use in

remedial education. One college was offering a fairly extensive "hands on" literacy course to its students.

(c) School Clinics

Four of the five clinics approached responded to the inquiry. Of the four only one had a microcomputer. Not one of the clinics was using the microcomputer for diagnostic or prescriptive purposes. The clinic with the microcomputer was using it for limited administrative purposes.

At the request of the Head of one of the clinics a visit was arranged where an extensive discussion took place regarding microcomputer use in remedial education. The Head in question, although not having a microcomputer at his clinic had been pushing the authorities for some time in order to acquire one. He was fully in favour of microcomputer use in remedial education and had been investigating possible applications. He was confident that microcomputers had a potentially valuable role to play and intended acquiring such devices as soon as finance became available. In the meantime he was encouraging and guiding remedial teachers in the use of microcomputers in remedial education - especially at schools where there were such devices.

(d) Teachers' Centres

One teacher centre had a number of microcomputers and offered on-going courses to in-service teachers. These were in the area of literacy and basic programming. No courses were specifically designed to introduce remedial teachers to possible remedial applications with the microcomputer. However, teachers were guided towards implementing in their classrooms what they learnt at the centre by concentrating on microcomputer applications to meet their specific needs. They had recourse to the centre for assistance and guidance whenever they required it. Although remedial teachers who might be attending courses were not necessarily instructed in specific remedial applications, advice was given in this area if sought.

The second teachers' centre had one microcomputer which was used for administrative purposes, and which in-service teachers could "reserve"

in order to work with it during "after school" hours. Nearby the teachers' centre in question was the audio-visual centre of the provincial education department. On being referred to the audio-visual centre, a meeting was arranged with the Head in order to establish the role of the centre in disseminating information and conducting courses for in-service teachers.

It was established that schools were regularly circularized in respect of on-going "hands on" literacy and programming courses. No courses thus far presented had been specifically aimed at remedial teachers. The audio-visual centre was, however, prepared to accommodate any group desiring a specific course. Such a course could range from an introduction to specific remedial applications to courses on remedial software selection and evaluation.

(e) Specialized Schools for the Specifically Learning Disabled : Nationally

Of the three schools surveyed, one was, as mentioned, in the Cape, another in the Transvaal and a third in Natal.

The school in the Cape did not have a microcomputer owing to financial restraints. The headmaster was fully aware of the potential benefit of microcomputer use in remedial education and indicated that he would acquire microcomputers as soon as finances became available.

The school in the Transvaal had a microcomputer department, but was utilizing it mainly at secondary school level to teach computer science as part of the Transvaal Education Department syllabus. Primary school pupils at the school with learning disabilities had limited access to the microcomputers.

The school in Natal had made an auspicious start with microcomputer use for learning disabled pupils. At its own initiative the school had acquired two Commodore 64 microcomputers. Commercial software had been used, but attempts were being made to develop teacher-designed software. Remediation was currently being attempted in areas of spelling, grammar,

syntax and mathematics. It was intended to introduce pupils to LOGO in the near future.

(f) Specialized Schools (Cerebral Palsy) : Cape Peninsula

Both of the above schools had enthusiastically embraced microcomputer use. The teachers in charge of the microcomputers were highly motivated and dedicated although one conceded a certain lack of experience. Despite this there was a commitment to acquiring the necessary knowledge and expertise in order to make a success of the microcomputer applications in the schools. In these schools, applications were in the area of assisting physically handicapped pupils by means of peripheral adaptations. Additional areas of applications were: enhancing the curriculum, applying prescriptive programmes and teaching literacy.

(g) Primary Schools

Of the ninety-five questionnaires sent out, there were 51 respondents (53,68%). The questionnaire (Fig. 18) was designed in such a way that feedback might be obtained in respect of three groupings:

Group 1 : Schools with microcomputers and using them for remedial purposes.

Group 2 : Schools with microcomputers, but not using them for remedial purposes.

Group 3 : Schools with no microcomputers.

6.4 The Questionnaire

QUESTIONNAIRE

MICROCOMPUTERS AND REMEDIAL EDUCATION

Please tick the appropriate box or answer where necessary.

SECTION A

1. Does your school have a microcomputer?

Y	N
---	---

If your answer to 1 is NO, please read the rest of the questionnaire as a matter of interest and attempt to respond to questions 10, 11 and Sections B1, 2 and 3.

2. Is use made of the microcomputer in any of the following spheres of one-to-one Remedial Education?

a) diagnosing

Y	N
---	---

b) prescribing (remediating)

Y	N
---	---

c) other (please state
.....
.....)

Y	N
---	---

If you answer to question 2 is YES, please respond to the following questions.

3. Whose idea was it to utilise the microcomputer as a remedial instrument at your School?

a) Principal

b) Class Teacher

c) Remedial Teacher

d) Parent

e) Other (please state)

4. Who administers the microcomputer-based remedial programme at the school?

a) Principal

b) Class Teacher

c) Remedial Teacher

d) Resource Room Teacher

e) Other (please state)

5. In which area of prescription do you use the microcomputer the most?

a) Maths

b) Spelling

c) Reading

d) Other (please state)

.....

.....

6. Do you know how to programme a microcomputer?

Y	N
---	---

7. Have you designed any programmes yourself?

Y	N
---	---

8. Do you use commercially available programmes?

Y	N
---	---

If YES, please indicate the names of the most successful programmes you have used:

.....

.....

.....

9. In terms of your goals, would you say that the programmes used have been successful?

Y	N
---	---

If your response to question 2 was NO please respond to the following:

10. Would you say that your reasons for not using a microcomputer in remedial education could be any of the following: (Tick as many as you feel are appropriate)

(a) No microcomputer at school

(b) Don't know anything about microcomputers

(c) Don't know enough about microcomputers

(d) Never thought of it

(e) Don't believe it can be of benefit

(f) Didn't think there were remedial programmes

(g) Haven't found any suitable remedial programmes

(h) Didn't know microcomputers were being used in remedial education

(i) Microcomputers at school are fully occupied for other purposes

10. (Contd.)

(j) Other (please state)
.....
.....

11. Should it be established that microcomputers can be of use in remedial education, would you use them?

Y	N
---	---

SECTION B

1. Intuitively, do you feel that a microcomputer could be more effective in remediating than a teacher? Please qualify

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

2. Do you have any other personal comments in respect of microcomputer use in remedial education?

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

3. If you don't have microcomputers at present for regular use in general, and remedial use in particular, what do you think might be a stumbling block in introducing them for any of the above purposes? (e.g. Finance, lack of interest)

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

Fig. 17 Questionnaire

- * Perceptual problems
- Motor co-ordination
- Games for reasoning ability
- Sequencing/Syntax
- Programmes in game format

Question 6

Do you know how to programme a microcomputer?

Y	N
7	44

Question 7

Have you designed any programmes yourself?

Y	N
3	48

Question 8

Do you use commercially available programmes?

Y	N
9	42

Question 9

In terms of your goals, would you say that the programmes used have been successful?

Y	N
7	1

Question 10

Would you say that your reasons for not using the microcomputer in remedial education could be any of the following?

- (a) No microcomputer at school
- (b) Don't know anything about microcomputers
- (c) Don't know enough about microcomputers
- (d) Never thought of it
- (e) Don't believe it can be of benefit
- (f) Didn't think there were remedial programmes
- (g) Haven't found any suitable remedial programme
- (h) Didn't know microcomputers were being used in remedial education
- (i) Microcomputers at school are fully occupied for other purposes
- (j) Other (please state)

28
2
4
0
0
3
4
1
6
0

Question 11

Should it be established that microcomputers can be of use in remedial education, would you use them?

Y	N
45	6

6.7 Group Responses to Questionnaire

(a) Group 1

In this group there were nine respondents. Of the respondents, four used the microcomputer for diagnostic purposes whilst all nine used it for purposes which they considered to be prescriptive. Although in eight cases it had been the idea of the principal to introduce the microcomputer in remedial education, it was in the majority of cases - eight - that the remedial teachers administered the remedial programmes.

The areas where the microcomputer was used the most for prescriptive purposes were:

Mathematics 6
 Spelling 6
 Reading 5

Other areas of application were cited as: "perceptual problems"; "motor co-ordination"; "games for reasoning ability"; "language, syntax, sequencing". One respondent had introduced LOGO.

All the respondents had employed commercially available software. Three stated that they had knowledge of programming, but none had designed his/her own programmes.

Group 1 response to the Questionnaire (Table 6)

SECTION A

Question 1

Does your school have a microcomputer?

Y	N
9	0

Question 2

Is use made of the microcomputer in any of the following spheres of one-to-one Remedial Education?

- (a) Diagnosing
- (b) Prescribing (remediating)
- (c) Other (please state)

Y	N
4	0
9	0
3	0

Question 3

Whose idea was it to utilize the microcomputer as a remedial instrument?

- (a) Principal
- (b) Class Teacher
- (c) Remedial Teacher
- (d) Parent
- (e) Other (please state)

8
0
1
0
0

Question 4

Who administers the microcomputer-based remedial programme at your school?

- (a) Principal
 (b) Class Teacher
 (c) Remedial Teacher
 (d) Resource Room Teacher
 (e) Other (please state)

1
0
8
4
0

Question 5

In which area of prescription do you use the microcomputer the most?

- (a) Maths
 (b) Spelling
 (c) Reading
 (d) Other* (please state)

6
6
5
5

- * Perceptual problems
 Motor co-ordination
 Games for reasoning ability
 Sequencing/Syntax
 Programmes in game format

Question 6

Do you know how to programme a microcomputer?

Y	N
3	6

Question 7

Have you designed any programmes yourself?

Y	N
0	9

Question 8

Do you use commercially available programmes?

Y	N
9	0

Question 9

In terms of your goals, would you say that the programmes used have been successful?

Y	N
7	2

Question 10

Would you say that your reasons for not using the microcomputer in remedial education could be any of the following?

- (a) No microcomputer at school
- (b) Don't know anything about microcomputers
- (c) Don't know enough about microcomputers
- (d) Never thought of it
- (e) Don't believe it can be of benefit
- (f) Didn't think there were remedial programmes
- (g) Haven't found any suitable remedial programmes
- (h) Didn't know microcomputers were being used in remedial education
- (i) Microcomputers at school are fully occupied for other purposes
- (j) Other (please state)

N/A
N/A
N/A
N/A
N/A
N/A
N/A
N/A
N/A
N/A

Question 11

Should it be established that microcomputers can be of use in remedial education, would you use them? (Continue to use them)?

Y	N
9	0

(b) Group 2

The fourteen respondents not using the microcomputer for remedial purposes cited the following reasons for not doing so:

- | | |
|--|---|
| (a) Don't know anything about microcomputers | 1 |
| (b) Don't know enough about microcomputers | 4 |
| (c) Didn't think there were remedial programmes | 2 |
| (d) Haven't found suitable remedial programmes | 3 |
| (e) Microcomputers are fully occupied for other purposes | 6 |

Of the fourteen respondents, thirteen stated that they would utilize the microcomputer if it was found to be successful as a remedial aid.

Group 2 response to the Questionnaire (Table 7)SECTION AQuestion 1

Does your school have a microcomputer?

Y	N
14	0

Question 2

Is use made of the microcomputer in any of the following spheres of one-to-one Remedial Education?

- | | |
|-------------------------------|--|
| (a) Diagnosing | |
| (b) Prescribing (remediating) | |
| (c) Other (please state) | |

Y	N
0	14
0	14
0	14

Question 3

Whose idea was it to utilize the microcomputer as a remedial instrument?

- | | |
|--------------------------|--|
| (a) Principal | |
| (b) Class Teacher | |
| (c) Remedial Teacher | |
| (d) Parent | |
| (e) Other (please state) | |

N/A
N/A
N/A
N/A
N/A

Question 4

Who administers the microcomputer-based remedial programme at your school?

- (a) Principal
- (b) Class Teacher
- (c) Remedial Teacher
- (d) Resource Room Teacher
- (e) Other (please state)

N/A
N/A
N/A
N/A
N/A

Question 5

In which area of prescription do you use the microcomputer the most?

- (a) Maths
- (b) Spelling
- (c) Reading
- (d) Other (please state)

N/A
N/A
N/A
N/A

Question 6

Do you know how to programme a microcomputer?

Y	N
0	14

Question 7

Have you designed any programmes yourself?

Y	N
0	14

Question 8

Do you use commercially available programmes?

N/A

Question 9

In terms of your goals, would you say that the programmes used have been successful?

N/A

Question 10

Would you say that your reason for not using the microcomputer in remedial education could be any of the following?

(a) No microcomputer at school	0
(b) Don't know anything about microcomputers	2
(c) Don't know enough about microcomputers	4
(d) Never thought of it	0
(e) Don't believe it can be of benefit	0
(f) Didn't think there were remedial programmes	2
(g) Haven't found any suitable remedial programmes	3
(h) Didn't know microcomputers were being used in remedial education	0
(i) Microcomputers at school are fully occupied for other purposes	6
(j) Other (please state)	0

Question 11

Should it be established that microcomputers can be of use in remedial education, would you use them?

Y	N
13	1

(c) Group 3

There were 28 respondents in this group. All but five - who were undecided - indicated that they would use the microcomputer if it was found to be a useful remedial aid. In reply to the question (in Section B) "If you don't have a microcomputer at present for regular use in general and remedial use in particular, what do you think might be a stumbling block in introducing them for any of the above purposes?" the respondents reacted as follows:

(a) Finance	28
(b) Don't know enough about microcomputers	4
(c) Never thought of it	1
(d) Ignorance!	1
(e) Lack of space	1
(f) Lack of interest from principal	2

Group 3 response to the Questionnaire (Table 8)SECTION AQuestion 1

Does your school have a microcomputer?

Y	N
0	28

Question 2Is use made of the microcomputer in any of the following spheres of one-to-one Remedial Education?

- (a) Diagnosing
- (b) Prescribing (remediating)
- (c) Other (please state)

Y	N
0	28
0	28
0	28

Question 3

Whose idea was it to utilize the microcomputer as a remedial instrument?

- (a) Principal
- (b) Class Teacher
- (c) Remedial Teacher
- (d) Parent
- (e) Other (please state)

N/A
N/A
N/A
N/A
N/A

Question 4

Who administers the microcomputer-based remedial programme at your school?

- (a) Principal
- (b) Class Teacher
- (c) Remedial Teacher
- (d) Resource Room Teacher
- (e) Other (please state)

N/A
N/A
N/A
N/A
N/A

Question 5

In which area of prescription do you use the microcomputer the most?

- (a) Maths
- (b) Spelling
- (c) Reading
- (d) Other (please state)

N/A
N/A
N/A
N/A

Question 6

Do you know how to programme a microcomputer?

Y	N
0	28

Question 7

Have you designed any programmes yourself?

Y	N
0	28

Question 8

Do you use commercially available programmes?

N/A

Question 9

In terms of your goals, would you say that the programmes used have been successful?

N/A

Question 10

Would you say that your reason for not using the microcomputer in remedial education could be any of the following?

- (a) No microcomputer at school
- (b) Don't know anything about microcomputers
- (c) Don't know enough about microcomputers
- (d) Never thought of it
- (e) Don't believe it can be of benefit
- (f) Didn't think there were remedial programmes
- (g) Haven't found any suitable remedial programmes
- (h) Didn't know microcomputers were being used in remedial education
- (i) Microcomputers at school are fully occupied for other purposes
- (j) Other (please state)

28
0
0
0
0
0
0
0
0
0

Question 11

Should it be established that microcomputers can be of use in remedial education, would you use them?

Y	N
23	5*

*Undecided

The second part (Section B) of the questionnaire was designed to gauge certain attitudes to microcomputer use in remedial education. The following question was posed: "Intuitively, do you feel that a micro-computer could be more effective in remediating than a teacher?"

Of the 46 respondents 30 responded negatively, two positively, whilst the remainder either did not respond or were undecided. Many stated that they would regard the microcomputer as a valuable additional aid to be used as a prescriptive device in certain areas or as an extension of teacher-based work. The overwhelming feeling was that there was no substitute for the human interaction between teacher and pupil.

A random selection of comments qualify this view.

"No, the teacher/pupil relationship is vital in the remedial situation for support, motivation and emotional contact."

"No, nothing can take the place of a sympathetic and capable teacher, but a microcomputer could be a valuable teaching aid."

"No, it is an aid."

"It can supplement, not substitute, for the remedial teacher."

"No, one of the most important things about remedial teaching is the emotional support provided for the child. No computer can do this."

"Never, I would consider it a very good aid."

"No! No the machine can never take the place of the teacher."

"No, the human touch and interest in a child will always be very important. Love and understanding must play their part."

"No, but a microcomputer would assist a remedial teacher most successfully."

"No, I do not think that a microcomputer can take the place of a remedial teacher. Remedial children need personal help, encouragement and t.l.c."

and

"Yes, because it is in a way far more objective than a teacher and is not influenced by emotions and frustrations which can be a hinderance to effective remedial teaching!"

6.8 Conclusion

It appears evident from the survey of applications and attitudes that not much is being done regarding microcomputer applications in remedial education. In the absence of a clear directive from the educational authorities the higher educational institutions have failed to take a lead and this lack of action has filtered right down to the lowest level in the hierarchy - the remedial teachers in the schools. Progress made abroad in the United Kingdom and the United States points to a significant role for the microcomputer in remedial education and individuals and institutions need to take up the reins locally in order to create some sort of infrastructure.

It is disturbing, when so much information is being disseminated in respect of microcomputer use in education in general, that universities and training colleges as educational leaders have failed to investigate the possibilities of instigating programmes for microcomputer use in remedial education.

Data gathered via the questionnaire seems to suggest that remedial applications are not regarded as high priority areas when it comes to using the microcomputer in schools, as fewer than half the schools having a microcomputer used it for this purpose. Those schools which have perceived its possible value in this sphere, and are using it to this end need to be commended.

Of those schools utilizing the microcomputer for remedial purposes, it is perhaps significant that in the majority of cases the idea for microcomputer use came from the principal - or instructional leader in the school. This is a healthy trend as it suggests that principals are keeping abreast of the benefits to be derived from new technology. It could, conversely, be a negative reflection on remedial teachers who thus appear not to have kept abreast, thereby possibly foregoing an opportunity of becoming acquainted with a potentially valuable educational aid.

Mathematics and spelling dominate the area of applications possibly suggesting that where drill, practice and repetition are required, the microcomputer can be used successfully; especially in the light of the fact that the majority of the respondents here felt that their prescriptive goals were achieved. In schools having microcomputers but not using them for remedial purposes, evidence seems to suggest that there is an urgent need to expose more remedial teachers to the microcomputer and its uses in order for them to appreciate its worth. The fact that six of the thirteen respondents were unable to use the microcomputer because it was occupied for other purposes suggests that in many areas remedial education is still regarded as the poor relation. Twelve of the thirteen respondents here indicated their willingness to use the device if it was found to be a successful remedial aid. This is encouraging.

It indicates that some kind of in-service programme should be considered to expose remedial teachers to the various microcomputer applications in this branch of education. The majority of respondents in the group which had no microcomputer at their school significantly indicated that they were prepared to use the microcomputer in remedial education if it should be established as being a successful aid. On the other hand this ideal might be hampered by the fact that for many schools finance is still the major obstacle, although "teacher education" might also still be required in some cases.

It is significant and encouraging that teachers feel so strongly about the warm, human contact in the remedial teaching situation as is evinced by the fact that the vast majority do not envisage the microcomputer being more effective than, and thereby possibly replacing the remedial teacher. The attitude of the warm, human approach is probably due to the high professional standards inculcated in remedial teachers at universities and colleges. It might be suggested, however, that owing to the small number of teachers who have actually utilized microcomputers in the remedial situation, many of the respondents had reacted emotionally to this aspect because of lack of knowledge of microcomputers in general. This is speculative, however, and it must be assumed that in the future, many more remedial teachers will be exposed to, and utilize the microcomputer as a remedial aid. It appears, however, that they have no intention of abdicating their role entirely to this so-called "machine"!

In the short-term, action should be taken to remedy the situation by having advisors in the various departments of education take steps to introduce at least at teacher centre level, in-service courses to acquaint remedial teachers with the role of the microcomputer in remedial education. These courses can be structured to introduce teachers to various applications as well as software uses. Universities should urgently address themselves to the question of including electives in their teacher training courses, programmes to introduce and acquaint teachers with the above aspects of microcomputer use in remedial education.

CHAPTER SEVEN

7.0 CONCLUSIONS

7.1 Introduction

In the course of the study reference has been made to numerous possible applications of the microcomputer in remedial education. These applications have been postulated by various theorists. The diagram (Fig. 18) below outlines the various applications. The benefits of these applications will be highlighted in this chapter.

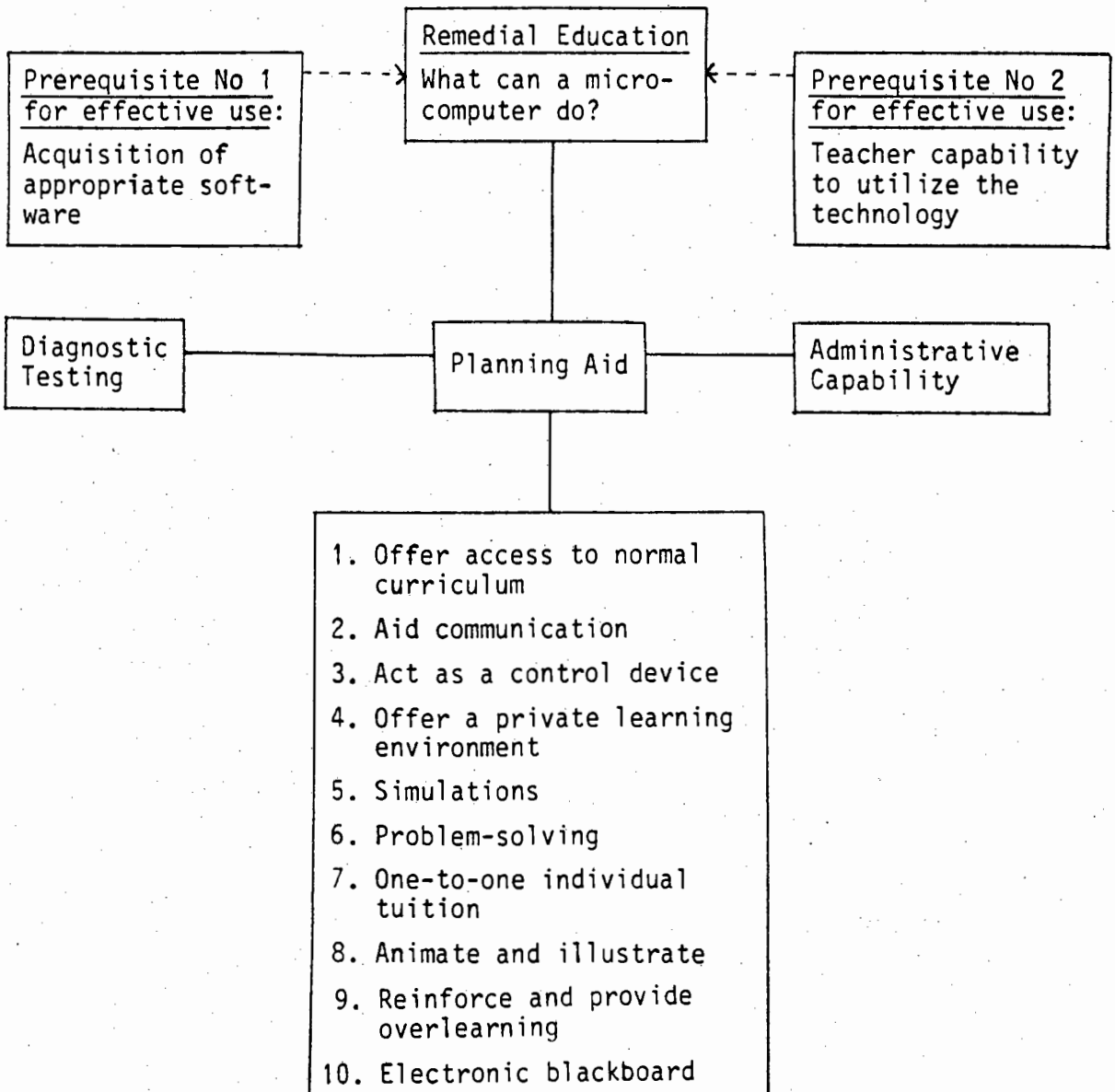


Fig. 18 Remedial Education : What Can a Microcomputer Do?

By creating a scenario of the procedure of diagnosis and programme design these applications will be focussed on in more detail in order to indicate how the microcomputer can make a dynamic contribution in the remediation of pupils with a general or specific learning disability.

It will be appropriate at this point to make a distinction between these two categories:

A specific learning disability means that the child passes some subjects but fails others. For example, he may pass all subjects but keeps on failing maths, or he may be quite good at maths but fail any subject that requires skill in reading. Another example might be a child who can do maths and read quite well, but who is hopeless when he has to write down and spell his work.

It is usually (but not always) easier to help a child with a specific learning disability. The remedial teacher can concentrate on one weak area instead of having to cover many different areas.

A general learning disability means that the child finds all school work difficult even though his intelligence is normal. Such a child might easily be called "lazy" because he seems quite clever enough to learn if he wants to. Of course this is not true since the child with a general learning disability genuinely finds learning difficult. (Cosford, 1982)

7.2 Diagnosis and Programme Design : A Hypothetical Scenario

A child might have a learning disability because of poor functioning in certain perceptual areas. These perceptual problems could lead to learning problems with language, reading, spelling and maths. If a child is suspected of having a learning disability, he may be tested or diagnosed in order to find the area of deficit. This may manifest as a specific or general learning disability.

There are various levels at which a child can be tested before a prescriptive programme is designed and implemented. It is not the intention to

discuss in detail the contents of tests here, suffice to say that initially an IQ test is regarded as one of the most important tests to be done. Tests such as the Stanford - Binet-type test or the Weschler-type test can be administered. The results of these tests are given as a mental age or as an IQ. The Stanford-Binet-type test tends to have a perceptual slant as well as testing the ability of the child to read, comprehend and cope with mathematical concepts. The Weschler-type test provides a verbal and a non-verbal IQ. The scores acquired on these tests can be compared against the accepted categories and it can thus be determined whether the pupil is functioning according to what is expected of a pupil of his/her age.

When the mental age of the pupil has been obtained from the testing, it can be determined whether that pupil possibly has a learning disability by comparing his mental age to his "reading or maths age". If his reading or maths age is below his mental age it indicates a learning disability. The pupil's "reading or maths age" can be established by applying scholastic tests in specific subject areas. It was pointed out earlier that deficits in areas such as reading, maths and spelling might have been brought about as a result of perceptual problems. It is therefore appropriate to administer perceptual tests as well. The basic tests here are auditory perception tests and visual perception tests. The former tests provide information of the pupil's ability to cope with auditory discrimination or auditory sequential memory whilst the latter will measure some of the following areas; visual motor co-ordination, visual memory, position in space, visual sequencing, visual closure, visual figure ground, and visual discrimination.

When these tests have been administered a profile is drawn up which indicates clearly whether a child has a specific or general learning disability. The remedial teacher must then design a prescriptive programme to remediate the areas of deficit. It must be borne in mind that not only the symptoms but the cause must also be treated. If a child has a reading problem because of poor visual discrimination for example, the prescriptive programme must deal with strategies to cope with the reading problem as well as with the perceptual problem.

After the remedial teacher has diagnosed the pupil the prescriptive programme is designed. When the teacher designs his prescriptive programme he will consider carefully teaching strategies as well as appropriate apparatus. The following section will highlight applications that are available to the remedial teacher that can be delivered via the microcomputer.

7.3 Applications for Incorporation in the Programme Design.

7.3.1 Drill and Practice

As has been pointed out earlier, drill and practice is an area of micro-computer delivery that has been criticized because many individuals think it is dull and repetitive. Some programmes might be dull, but to accuse them of being repetitive is to miss the point when it comes to dealing with learning disabled pupils. Drill and practice can actually stimulate learning. The computer never gets bored with repetition and is therefore well qualified to meet the needs of specifically learning disabled pupils who need to practice basic skills. Going through any directory of software it will be seen that by far the majority of programmes are of a drill and practice nature. An important principle of remedial teaching is repetition and 'overlearning'. Drill and practice programmes answer to this need. Many mathematics and spelling programmes fall into this category. Maths and spelling problems usually require repetition to evaluate the skill for further practice. Aspects to be considered when employing relevant drill and practice programmes are the following:

- (a) The microcomputer allows independence; the learning disabled pupil can work independently without relying too much on the teacher. He can make errors 'in private' without getting embarrassed. These errors, and the performance, in general can be monitored for later teacher analysis.
- (b) The microcomputer is non-emotional; in drill and practice programmes the microcomputer will present the question and wait for answers impartially. It can distinguish between a right and a wrong answer, thereby giving positive reinforcement for right answers and encouraging the pupil to try again when he has an incorrect answer.

(c) Drill and practice delivery is at the pupils' pace; the drill and practice programme is designed to take cue from the pupils' responses; the programme proceeds only when the child responds correctly.

(d) Drill and practice can be motivating. Although bought or teacher-made flashcards can be used in teacher-based drill and practice situations, the microcomputer scores here, because of the motivational effect. Children are willing to do microcomputer drills over and over again.

Hagen (1984) points out there are some potential disadvantages to drill and practice in that there is the danger that:

- it will become the only use with microcomputers
- little care will be given to the software selection.

Obviously these problems must be borne in mind and surmounted. Hagen (1984) further points out that drill and practice, by microcomputer using appropriate software, is by a long margin the most popular use of the microcomputer in education of learning disabled children because it is of educational value, it is easy to do and non-threatening to the educators themselves.

7.3.2 Perceptual Problems

As pointed out earlier many children have learning problems because of faulty perception. This can be visual or auditory. When remediating a specific scholastic area of deficit, the teacher might have to consider the underlying aetiology which might be perceptual. In the prescriptive programme, perceptual training would be integrated with specific remediation in the scholastic area of deficit.

Microcomputer software and delivery are able to present the teacher with ways and means of tackling the problem of faulty perceptual development. Peripheral devices are available which can be utilized to effect audio and visual delivery. In respect of auditory delivery, the CCD (Cassette Control Device) can be referred to. Here the tape recorder is synchronized with text on the screen of the microcomputer via a special switch.

This device presents pupils with a wide variety of drill and practice authority systems and concept materials with simultaneous audio and visual presentation. Another method of achieving visual and auditory presentation is through speech synthesis. Synthesizers exist that can "speak" any text file simultaneously with the screen presentation. Although the programmes mentioned above are more suited to moderately and severely visually and hearing-impaired pupils, they are two programmes that indicate the level of sophistication to which microcomputer delivery has developed. The point to make here is that the means do exist to use voice on the computer. In the future this can be developed to be utilized with generally learning disabled children as a means of developing and remediating auditory and visual perceptual deficits.

At present there are numerous programmes available that are more visually based in dealing with perceptual problems. In England, the West Midlands branch of the MEP has developed a programme concerned with perceptual development. The programme which is designed to be delivered through a BBC microcomputer consists of a large number of perceptual development programmes designed for children with moderate or severe learning disabilities (developmental ages 5 - 9). The programmes cover visual memory (numbers, letters and shapes), sequential memory discrimination (numbers, shapes, letters and words), matching and discrimination (pictures, shapes, letters and words), and scanning and sorting by size.

An extract from the MEP/CET Information Sheet No. 4 (1983) regarding Software for Children with Moderate Learning Difficulties, (Fig. 19) indicates the large number of programmes available for dealing with perceptual problems.

No.	Publisher	Title	Age Range	Price	Teaching Objective
8	Deane D.M.	Maze-walker	-7/7-11	Tape/under£5	Spatial perception, orientation, concentration, manual dexterity and left/right awareness.
145	Dorling Kindersley	Sketch-Pad	7-11	Tape:£5-10	Design, hand-eye co-ordination, l/r & up/down tracking, colour discrimination, planning.
58	E.S.R./S.E.S.S.	Jigsaw Puzzle	7-11/11+	Tapes:£5-10 disc:£10-15	Memory, visual perception, logical thinking, problem solving.
121	E.S.R./S.E.S.S.	Sliding Block Puzzle	7-11/11+	Tape or disc:£5-10	Problem solving, logical thinking, memory, visual perception.
52	Educational Software	Mix'n'Match	-7/7-11	Tape:£10-15	Colour matching, shape matching, shape recognition, hand-eye co-ordination.
46	Educational Software	Paint Brush	-7/7-11	Tape: with pen (£40-45)	Painting, drawing, hand-eye co-ordination, imagination, visual discrimination, shape recognition.
54	Educational Software	Synthesiser	7-11	Tape:£5-10	Early music, experiments with sounds. Also language, communication, creative writing.
22	Ginn	Hunt the Thimble	7-11/11+	Tape:£20-25	Problem solving, decision making and logical thinking.
41	L.T.S.	Your Adventure	7-11/11+	Tapes:£5-10 (schools)	Reading, language & communication, group co-operation.
13	Langman Ladybird	Sheepdog	7-11	Tapes:£10-15	Content free - as determined by teacher. Spatial perception, orientation, compass points.

Fig. 19 Programmes Dealing with Perceptual Problems

7.3.3 Language/Reading

Language and reading problems are areas which create much concern amongst parents and teachers and much attention has been given to developing software to be prescribed in this sphere. Reference to any software directory will reveal numerous programmes designed for language, reading, writing, vocabulary, word sequencing, sentence sequencing and sentence construction. Teachers should be circumspect when selecting software for reading as there is a plethora of material in respect of styles and approaches and not all reviews have been positive. However the fact is, that software is being developed in this very significant area of learning disabilities. Programmes are constantly being updated and developed and those that seem to be worthy of consideration for use are those that emanate from "workshop" situations where remedial teachers and remedial pupils have been involved. Programmes such as the one below developed by the Westgate School in Winchester, England indicate the kind of programme which is available to pupils with a reading deficit.

The software in question was designed to assist in developing reading strategies by individuals or groups. There were four programmes.

- (a) Cloze Procedure : develops appreciation of context, syntax vocabulary and style.

- (b) Sequencing : develops logic and progression (including simpler sequencing skills such as alphabetical order and rhyming schemes).
- (c) Skimming : develops rapid textual assimilation.
- (d) Scanning : gives practice in selection and evaluation.

Language is an area where learning disabled pupils find difficulty; especially written language. Weiner (1980) points out that the work of learning disabled pupils that falls into this category is often characterized by graphic imperfections (erasures, pencil pressure marks, size and spacing irregularities) misspellings (including phonetic spelling, letter or syllable omissions) grammatical and semantic errors. In order to attempt to eliminate these problem areas, the microcomputer can be prescribed in the form of the word processor. The concept of utilizing word processing as a learning tool is gaining acceptance. The writer's own experience in observing work with the Wordwise (1984) word processing programme has indicated this.

Interacting with software called typing tutors, pupils are in a position to learn how to manipulate the keyboard. Some of the software is designed as games, whilst other is straightforward drill and practice. Teachers are now in a position to enable pupils to be introduced to word processing in order to write compositions or short stories. The rationale here is that even if a child cannot write with a pencil and paper he or she can probably push a key or switch to generate a specific letter. If errors in verb tense, spelling or punctuation are made, they can be corrected without retyping the entire text because the text can easily be reorganized or edited by simple keyboard commands.

For learning disabled pupils it is the power to correct, manipulate and reorganize written language without recopying that makes word processing such an effective prescriptive tool.

Behrman (1984) suggests that the benefits of word processing can be enumerated as follows:

- (a) There is no penalty for revising.
- (b) It is easy for pupils to experiment with writing.
- (c) Interest in the writing task is maintained.
- (d) Editing is simple: spelling, punctuation and grammar can be changed or checked.
- (e) Writing and editing are less time consuming.
- (f) Frustration is minimized.
- (g) It is easy to produce perfect copy.
- (h) Computerized spelling checkers are available.

7.4 Integration with the Curriculum

The microcomputer can be introduced into school to be used as a motivator and also assist with the reinforcement of learning skills. There is nothing wrong with these two educational objectives, especially as they apply to the learning disabled pupil. However, as already mentioned, there are wider applications. One of these is curricular development. The microcomputer can serve to widen curricular horizons for learning disabled pupils by remedying areas of weakness as previously pointed out, but especially by supporting and extending work already successful and opening up access to new experience. Stephen Clamp (1983) suggests that the microcomputer should be used to "extend" rather than "restrict" curriculum development.

The Warnock Report (1978) suggested that the "overall aims of education are the same for all children". The educational needs of every child should be determined in relation to these aims. The Warnock Report recognized that the curriculum in any school is necessarily a selection from a much wider range of possibilities, but stated that for children with special needs, every attempt should be made to see that the chosen objectives are as near in scope and quality to those of other children of the same age as is practicable, given the nature and degree of the children's disabilities. These aims can be considered as follows:

... to enlarge a child's knowledge, experience and imaginative understanding, and thus his awareness of moral values and capacity for enjoyment; ... to enable him to enter the world after formal education is over as an active participant in society and a responsible contributor to it, capable of achieving as much independence as possible.

(Warnock, 1978: para 1.4)

As pointed out in Figure 18, the versatile nature of the microcomputer enables it to be used in individualized instruction with learning disabled pupils in specific areas of deficit. However, like many other educational developments, its optimal effectiveness depends on the appropriateness of its introduction and development in the special educational context. Green, Hart, McCall and Staples (1982) state that it cannot replace a clearly specified curriculum but it will certainly enhance an existing competently organized programme of learning. In integrating the microcomputer with the curriculum, a great amount of imagination must be used. Its use must be linked with careful consideration of the intricacies of the curriculum. As pointed out here, the purpose is to give learning disabled pupils equal access to the curriculum bearing in mind that they have specific or general learning disabilities. Because of the motivational aspects of microcomputer interaction, learning disabled pupils can gain access to the curriculum in a number of ways as suggested by Clamp (1983).

- (a) Teaching computer awareness and simple programming skills is a useful addition to the curriculum.
- (b) Using the microcomputer as a tool for discovery.
- (c) Programmes are being developed that are guiding pupils to an appropriate line of questioning.
- (d) Simulation and problem-solving.

The types of applications enumerated above which can be used to extend the curriculum of learning disabled pupils are explained in more detail here.

Teaching computer awareness and simple programming skills can be an effective addition to the curriculum. If carefully directed through simple steps by the teacher in a language such as BASIC the pupil can design a very simple programme - such a programme to add or subtract two numbers. Instructing the microcomputer what to do, gives a pupil confidence and indicates to the user that he is in control of the situation. It also serves to introduce pupils to this new technology which is undoubtedly going to have a major effect on their lives.

In a previous section mention was made as to how LOGO can be used as a problem-solving mechanism. It is, of course, important that the pupil is guided towards an appropriate line of questioning here. This is particularly important when interacting with a programme such as LOGO.

Pupils can be taught to tackle an appropriate line of questioning in various situations by letting them interact with programmes designed for this purpose. Once they have grasped the questioning technique they can interact with more sophisticated problem-solving models in order to enhance this skill even further.

Programmes which are appropriate here are Tecmedias ANIMAL (1983) and Acornsofts TREE OF KNOWLEDGE (1983)

The former programme (Fig. 20) requests the pupil to think of an animal and to ask a series of questions until the microcomputer puts forward a suggestion of the animal it thinks the pupil has in mind. This interactive verbal game is therefore similar in a way to the popular game "twenty questions" except that the programme has to be taught the necessary facts by the pupil.

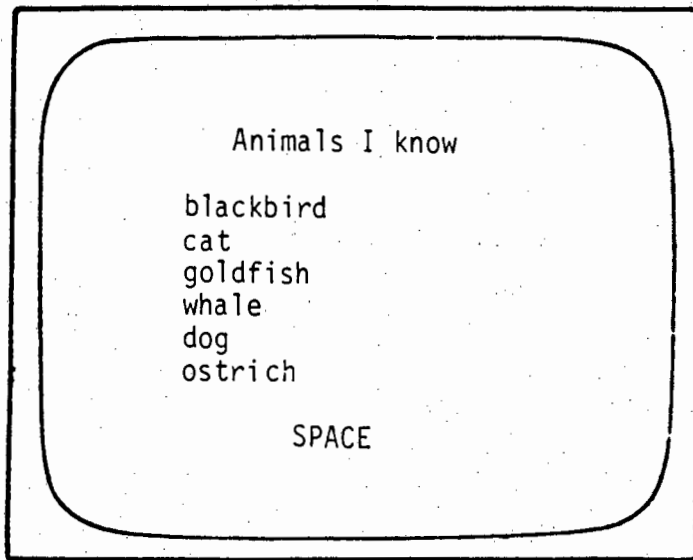


Fig. 20 Animal

At the outset the programme knows the name of just two animals, goldfish and blackbird, and can distinguish between them only by the ability of the first to live in water. The point of the game is to build up the programme's knowledge so that it can guess correctly whatever animal the pupil has in mind. This is done in stages by requiring the pupil to think each time of an animal, devise a question which will distinguish the latest animal from the previous one, and then tell the programme the answer to the question.

Comments regarding this programme (CET/MEP, 1983) point out that the programme has been proved suitable for use with a small group of learning disabled pupils. It was said to promote logical thinking, give practice in formulating relevant questions, stimulate group discussion and develop knowledge about animals.

Language development was, importantly, at the pupil's own pace using the pupil's personal store of knowledge. The reading level is suitable for slow learners.

TREE OF KNOWLEDGE (Fig. 21) is also an interactive verbal game extending the idea embodied in ANIMAL. The educational objectives are to teach the pupil categorization of information and its storage and retrieval.

The pupil is initially asked to choose a category which can be of any recognizable kind (e.g. plants, sounds or games). The pupil is then asked in successive steps to name new members of the category.

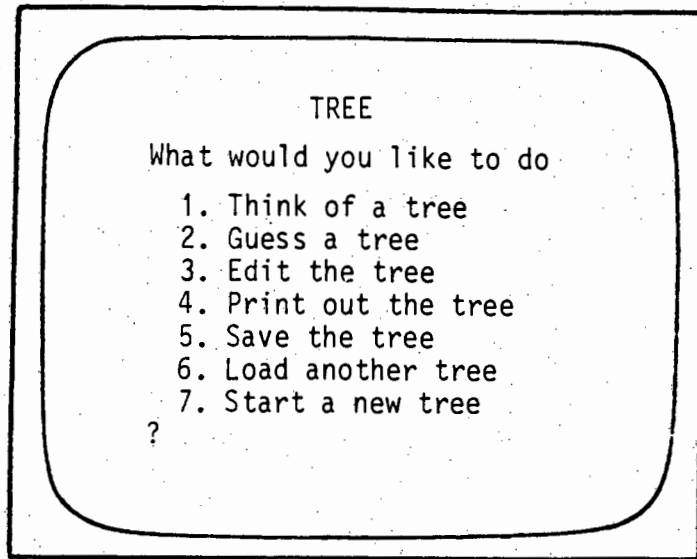


Fig. 21 Tree of Knowledge

At each step the pupil is required to supply a question which will distinguish by a simple yes/no answer the latest entry from the previous one.

The programme has been reported (CET/MEP, 1983) to be very useful and helpful both for developing language skills and for practice in question formulation, classification and decision-making. It was also reported that the repeated reappearance of sentences the pupil had framed was valuable as a reading aid.

When pupils have mastered skills acquired by interacting with above such programmes they can extend their decision-making and problem-solving skills by interacting with programmes such as ODELL LAKE published by MECC Publications in Minnesota (1982). ODELL LAKE is readily available and can be delivered through Apple microcomputers. The programme has a reading level which enables it to be useful with pupils as low as Standards 3 or 4. The educational objectives of the programme are:

- To simulate the life of a fish and to make the decisions necessary for survival.
- To understand the food (predator-prey) relationship between fish.
- To generalize a size relationship between fish.
- To create an awareness for the plant and animal life forms found in water.

Figures 22-26 indicate the format of the game. The programme has clear instructions and all feedback is carefully worded so as not to embarrass the user if any so-called "wrong" decisions are made.

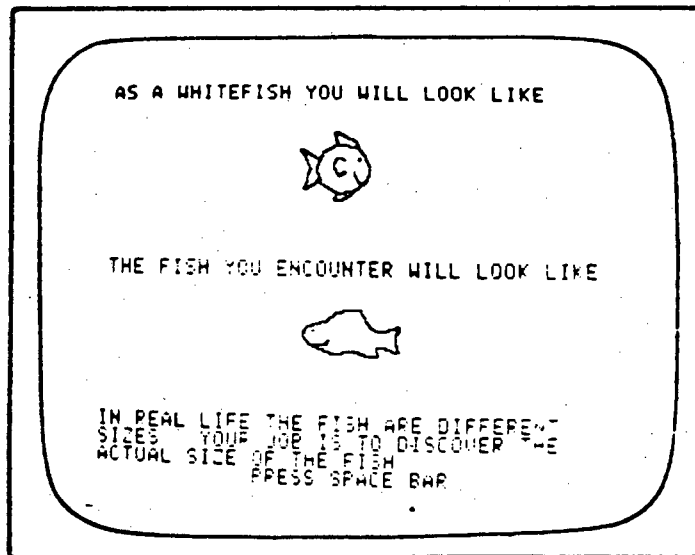


Fig. 22 Ode11 Lake : Format 1

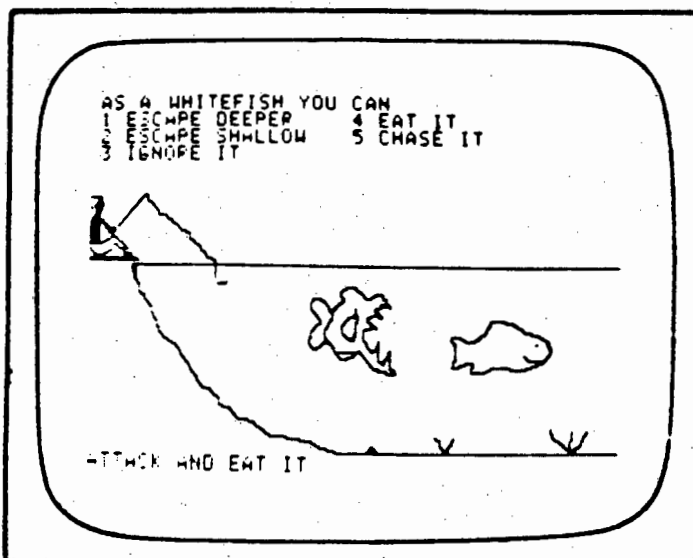


Fig. 23 Odell Lake : Format 2

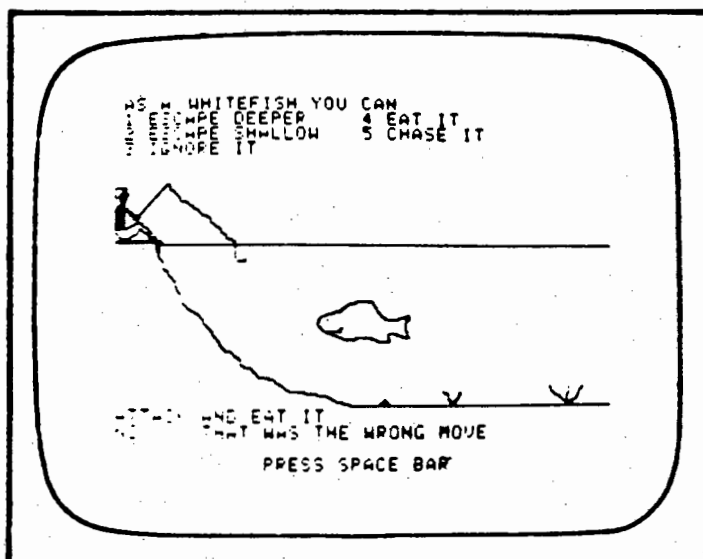


Fig. 24 Odell Lake : Format 3

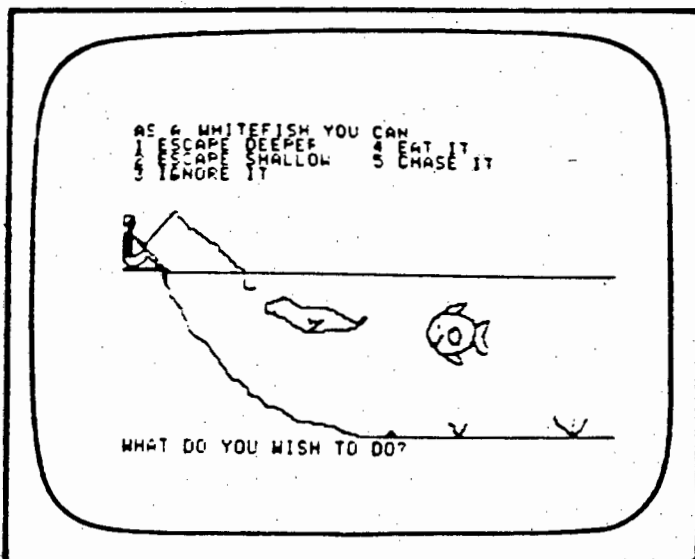


Fig. 25 Odell Lake : Format 4

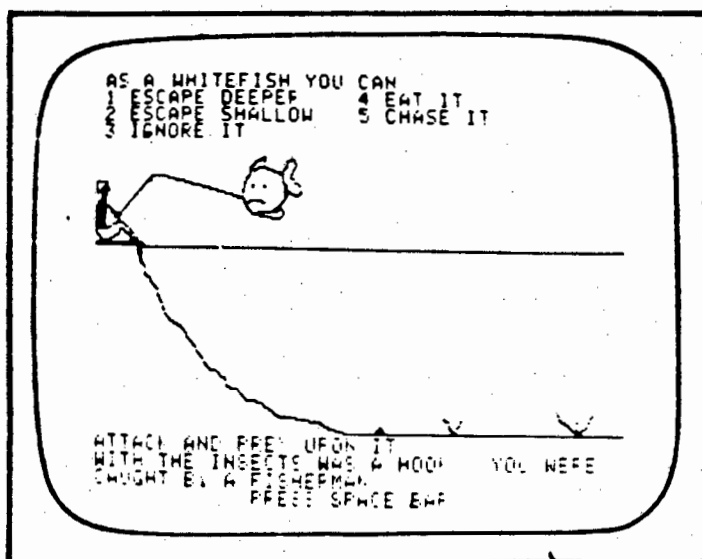


Fig. 26 Odell Lake : Format 5

The Programme is particularly useful as it teaches several general concepts of an ecological nature. Topics on fish, ecology and conservation abound in the primary school syllabus.

Another way of integrating microcomputers use with the curriculum is by interacting with simulation programmes.

Simulations allow learning disabled pupils to engage in yet a further type of discovery learning. Since simulations are programmes that are designed to emulate real-life situations and utilize principles of discovery for regular pupils they can be used with learning disabled pupils as well. Of course, it is essential when using simulations with such pupils that one ensures that the rules are not too complicated and that the text is at the correct reading level.

Simulation programmes do not necessarily provide reinforcement for correct answers, as there might be more than one correct answer. The micro-computer is in a position not to reveal the consequence or an answer until a response is made. This prevents the pupil from guessing, or the computer looking up the answer.

If, in a simulation that is teaching a skill such as shopping within a limited budget, too many "luxury" items are purchased, financial disaster might result. The pupil is able to learn problem-solving skills without initially embarking on the "real thing" and embarrassing himself in public. Since the simulation can be played repeatedly, the pupil can try different choices and see the logical results of those choices. He is thus involved in a discovery learning process.

Two simulation programmes that are particularly useful in teaching these skills are OREGON TRAIL published by MECC and GEOGRAPHY SEARCH published by McGraw-Hill Book Company (1982).

Both programmes are similar in content and require decisions to be taken in respect of journeys. Decisions have to be made regarding routes to be taken, money required, provisions to be ordered, dealing with enemies, etc. In each case, if a wrong decision is taken it can lead to disaster or even "death".

Figures 27-31 indicate the type of question posed and decisions that have to be taken in a voyage to the "New World".

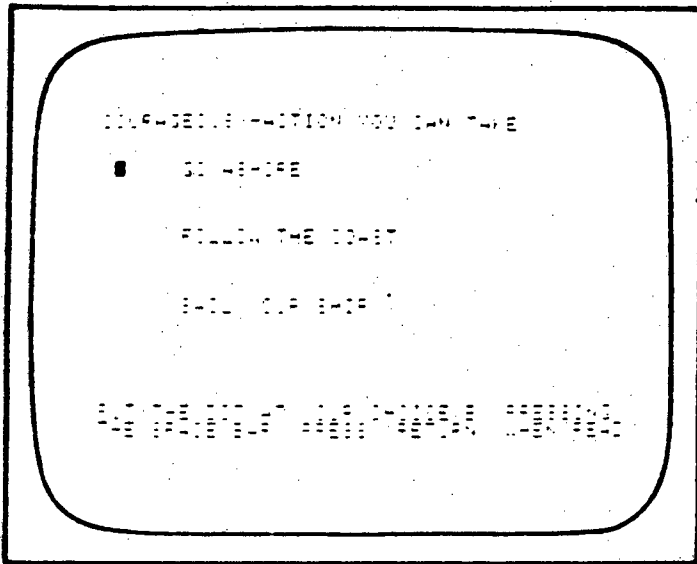


Fig. 27 Geography Search : Format 1

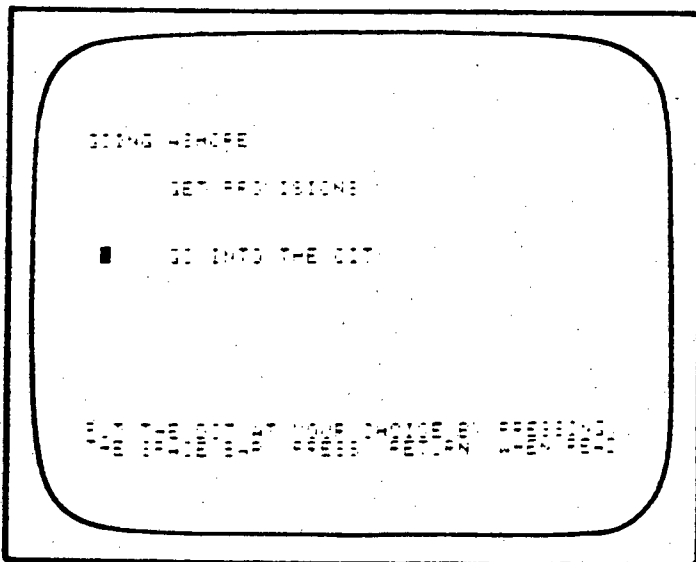


Fig. 28 Geography Search : Format 2

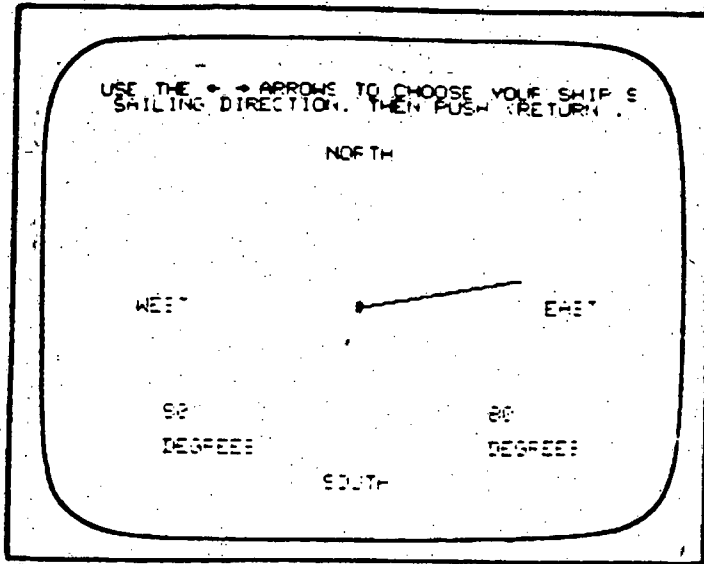


Fig. 29 Geography Search : Format 3

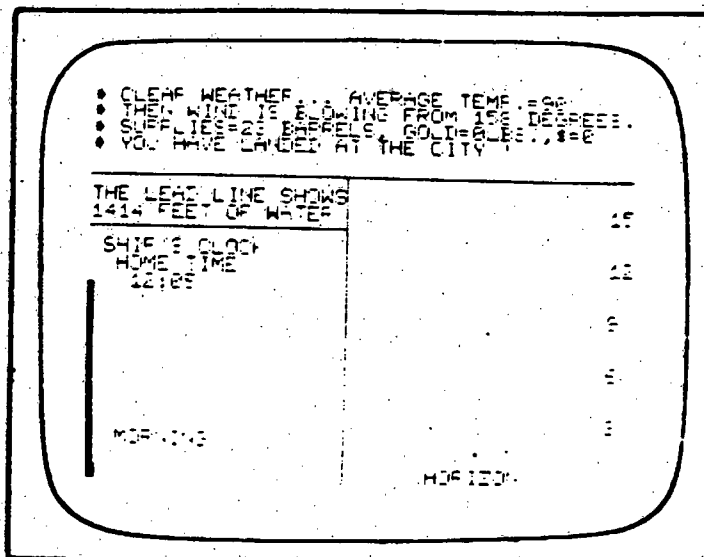


Fig. 30 Geography Search : Format 4

thereby increase the validity of the results.

Numerous software publishers as well as special educationists have developed, and are currently developing programmes which can be used in diagnosing and evaluating pupil performance. Software publishers are currently developing test scoring formats of two kinds. These formats consist of scoring services and test scoring microcomputer programmes. Both of these systems are designed to provide the remedial teacher with criterion-referenced test analysis in order to assist in the diagnosis, prescription and placement of learning disabled pupils. Behrman (1984) points out that all the major achievement test publishers currently offer criterion-references analysis reports for their achievement batteries. Examples in this area include tests such as the Iowa Test of Basic Skills, and the Metropolitan Achievement Test. The reports generated by these tests identify the skill mastery levels of individual pupils in the major subject areas for the items tested. The teacher is alerted to areas of academic strength and weaknesses. Additional programmes currently available are designed to provide individual pupil profile reports identifying learning strengths and weaknesses, cluster scoring for both grade and age, and standard scores. Programmes are available for ability tests such as the WISC-R and diagnostic instruments such as the Peabody Individual Achievement Test. A generic scoring programme, Microcomputer Scoring System published by Tesco Inc. (1985) can be used to score any standardized achievement or ability test, criterion-reference test or teacher-made test. Using an optical reader, the software computes a variety of scores, including raw and standard scores percentiles and grade equivalents.

While the primary use of microcomputer in diagnostic testing has been with administering standardized measurement instruments, they also can be valuable in classroom testing via teacher-made tests. They can assist the teacher in designing, constructing, administering and scoring teacher-made tests that address the specific needs of learning disabled pupils.

The following section outlines two teacher-made programmes which were developed for utilization in specific areas of deficit. The former is a

programme designed for diagnosing spelling problems in learning disabled pupils while the latter describes a prototype programme which has been used to both test and train language impaired pupils. Both systems compute raw scores, list correct and incorrect responses, and perform error analysis.

The Computerized Diagnostic Spelling Test (CDST) is an interactive BASIC programme that has been designed to emulate as closely as possible the administration and scoring procedures of the Diagnostic Spelling Test outlined by Kottmeyer (1970). The programme consists of four components (a) input of demographic data, (b) providing the pupil with directions, (c) presentation of spelling words, and (d) the scoring and diagnostic summary of results. Following is a description of each of these components.

Demographic Data : Once the programme has been loaded into the micro-computer, the CDST begins by prompting the examiner or, when appropriate the pupil, for the input of demographic data. The computer instructs the respondent to provide the following information:

- Pupil's name
- Date of birth
- Grade/Standard
- School
- Date of examination
- Place of examination
- Examiner's name

Each piece of information is typed into the computer following the prompt. The computer then stores this information and also calculates the pupil's chronological age for subsequent use.

Pupil's Directions : Following the input of the demographic data, the pupil is provided with visual and auditory test directions. The written directions are presented to the pupil via the computer monitor. Simultaneously, the same directions are presented to the pupil auditorially from a prerecorded cassette tape which is driven by the microcomputer.

Following the presentation of instructions, the pupil is instructed to begin the test, when ready, by pressing the "ENTER" key on the keyboard.

Word presentation : Once the pupil initiates the diagnostic programme the computer again drives the cassette recorder which begins to verbally present the 32-item word list from the Kottmeyer test. The words are presented to the pupil by: (1) saying the word in isolation, (2) using the word in a sentence, and (3) saying the word in isolation. A prompt to TYPE THE WORD is then flashed on the monitor, and the computer waits for the pupil's response. The next word is not presented until a response is typed by the pupil. Thus, the speed of presentation is totally pupil-controlled.

As the pupil types in each word, the microcomputer internally scores the response as correct or incorrect and stores the information. If the word is incorrect, the error type is identified and also stored. The pupil continues in the word list until he or she has completed the 32 words, at which time, word presentation stops and the pupil is instructed to tell the examiner he or she has finished.

Scoring and Diagnostic Summary : Following completion of the word list, by the pupil, the computer instantaneously provides the examiner with a comprehensive summary of the pupil's performance. The summary provides the teacher with a listing of pupil's (1) demographic data, (2) test summary, (3) error list, and (4) diagnostic error analysis. An example of a summary is shown in Figures 32-34.

The demographic data are simply a listing of the information input at the beginning of the programme with the addition of the calculated chronological age.

The Test Summary is listing of the numbers of words correct and incorrect as well as an estimate of the pupil's grade level. (Fig. 32)

The Error list provides the teacher with a list of misspelt words, along

with the correct spelling for these words. The correct spelling is provided so that when severe spelling problems exist, the teacher can easily determine the word the pupil was attempting to spell. Further, a comparison of the spellings often provides the teacher with a unique opportunity to study the pupil's problem. (Fig. 33)

The Diagnostic Error Analysis, which constitutes the most informative aspect of the programme, provides the teacher with a detailed listing of the types of problems the pupil is exhibiting. The diagnostic categories provide the teacher with specific problems, such as short vowels. These diagnostic categories can then be used by the teacher to provide specific remediation techniques to assist the pupil in overcoming the problem. (Fig. 34)

```

.....
• COMPUTERIZED DIAGNOSTIC •
• SPELLING TEST •
.....
DEMOGRAPHIC DATA
.....
STUDENT NAME BELLEWEN H
BIRTHDATE 06/28/71
CR 9-7
GRADE 5
SCHOOL PINE ELEMENTARY
DATE OF EXAMINATION 04/05/78
PLACE OF EXAMINATION E.C.S.U.
EXAMINER T. WASSERBERG

SUMMARY
.....
NUMBER CORRECT WORDS 11
NUMBER INCORRECT WORDS 21
GRADE LEVEL < 2ND GRADE

```

Fig. 32 CDST : Test Summary

ERROR LIST	
THE STUDENT SPELLED	
1	NOTE FOR NOT
2	GET FOR SET
3	SET FOR SIT
4	TRIN FOR THIN
5	LIX FOR LITE
6	DOME FOR DOWN
7	EVER FOR VERY
8	KEP FOR KEEP
9	COH FOR CODE
10	WYI FOR WHY
11	THOE FOR THOSE
12	SHO FOR SHON
13	WLSH FOR WLSH
14	STON FOR STON
15	WELL FOR WILL
16	WFER FOR WFER
17	SISTR FOR SISTER
18	SRIC FOR SRY
19	LITTLE FOR LITTLE
20	OH FOR ONE
21	WEE FOR WOULD

Fig. 33 CDST : Error List

DIAGNOSTIC ERROR ANALYSIS	
THE ERROR ANALYSIS INDICATES THAT THE STUDENT IS HAVING SOME DIFFICULTY WITH	
1	SHORT VOWELS
2	TWO VOWELS TOGETHER
3	VOWEL - CONSONANT E
4	OH - OI SPELLING OF OU SOUND
5	FINAL Y AS SHORT I
6	C AND F SPELLINGS OF THE F SOUND
7	WH, TH, SH, CH, NG AND ON SPELLING OF LONG O
8	DOUBLED FINAL CONSONANTS
9	EX SPELLING
10	PH SPELLING OF LONG P SOUND
11	LE ENDINGS
12	NONPHONETIC SPELLINGS

Fig. 34 CDST : Diagnostic Error Analysis

Wilson and Fox (1982) state that there is in both special education and bilingual education a critical need for innovative and effective assessment and intervention materials for language disorders. They suggest that microcomputers offer a delivery system which can increasingly be relied upon for unbiased bilingual testing and instruction

for the language impaired pupil.

Wilson and Fox (1982) suggest that in normal bilingual language acquisition, comprehension forms the basis for both monolingual and bilingual language development. It is suggested that both comprehension and production can be improved with receptive training; therefore, receptive language intervention materials should possibly assist a bilingual pupil to develop to his or her highest linguistic potential. It is therefore suggested that test materials which grow out of instructional methods, and hence can be prescriptive as well as descriptive in nature, are needed to accompany comprehension programmes for the bilingual language-impaired child.

It is pointed out that developments such as speech synthesis units have enabled authors and publishers to compile language comprehension testing and teaching programmes that can be used with non-reading language impaired pupils. When the audible component is combined with micro-computer graphics, the potential exists for developing dynamic language intervention programmes for learning disabled pupils (Wilson and Fox, 1982).

During the early 1980's Wilson and Fox began investigating the feasibility of converting receptive language tests and programmes into microcomputer courseware. After reviewing available hardware and peripherals, an Apple II plus based system was chosen with a graphics tablet - for picture generation, a Mountain Computer "Super Talker" to generate synthesized speech, a Sony Colour Monitor, a printer with graphics capabilities and two micro-floppy disc drives.

Wilson and Fox then set about developing and field-testing prototype courseware for testing and teaching sample prepositional concepts. The assessment courseware evaluated performance on three prepositions: in, on and under. Comprehension was tested using fifteen sets of three contrasting pictures of a pencil in, on and under the holder. The pupil was then asked to choose a picture; for example, "Show me, the pencil is in the holder". The pupil responds by pushing a button

under the appropriate picture.

After a first study had been carried out, and revealed that there was no test result difference between the microcomputer and conventional assessment, a Franco-American, French-speaking kindergarten pupil's comprehension of the same prepositions was tested. In this particular study both English and French comprehension was tested. The English version of the 45-item test was delivered via microcomputer while the French version was administered in the conventional manner. The test results showed that the pupil did comprehend the prepositional concepts in French, but his performance in English was at chance level.

The investigators contend that microcomputer-administered language comprehension testing appears to offer a viable alternative to conventional testing modes. Pupils, largely, preferred the microcomputer mode as well. It is pointed out that for bilingual language testing, microcomputer delivery offered the promise of a non-threatening, non-biased and non-discriminatory method.

In addition to the prototype testing programme the investigators have also field-tested a prototype instructional programme.

The outcome of the prototype study undertaken by Wilson and Fox and the success achieved convinced them that microcomputer courseware for bilingual language comprehension testing and instruction could be successfully developed.

Salend and Salend (1985) suggest that by modifying certain delivery modes, the microcomputer presents itself as a valuable device to be used separately or to complement conventional procedures in the diagnostic testing situation.

(a) Modifying Presentation Modes

It has been argued that the format of a diagnostic test, including its presentation mode, appearance and spatial organization can affect the performance of learning disabled pupils. These problems can be overcome

when working with a microcomputer. The remedial teacher can regulate the speed as well as the organization of the presentation. Certain critical information can be highlighted whilst distracting features which might interfere with the pupil's performance may be limited.

The teacher is in a position to regulate the speed of item presentation to match the needs of the pupil being tested and to test mastery of the subject matter. When speed is an important element in demonstrating mastery the microcomputer can present new items at fixed item intervals. Microcomputers can facilitate the organization of tests to optimize pupil performance. Sometimes a pupil becomes confused when he is confronted with too many items on a printed page. This confusion can affect performance. The microcomputer can present a single item in a frame if necessary. If more than one item is displayed on the screen, visual boundaries can be placed between them. Additionally, proper spacing of items on the screen can be attained easily when designing tests on the microcomputer.

Presenting tests on the microcomputer also can minimize poor performance that might occur owing to the appearance of the test. Graphics and other design options can improve the technical and educational quality and precision of the test. Often, computer printing can improve the legibility of the test, whilst the screen can provide pupils with a solid dark background that is free of extraneous stimuli.

Graphics and colour can be employed to improve pupil performance on tests by highlighting critical aspects of test items. Graphics and colour can also heighten pupil awareness of test directions by underlining or colour coding key words in items.

(b) Modifying Response Modes

Pupils who, because of certain disabilities have difficulty in responding to test items can use peripheral devices to assist them. For example a pupil with a handwriting problem can respond on a microcomputer through keypunching or using peripheral devices such as a light pen or a joystick to activate the microcomputer. A light pen, which is

a pen-like device that enables pupils to interact with the micro-computer by touching the pen to the screen, can be used for completing items such as multiple choice questions.

Tests that require handwritten responses are difficult for pupils with fine motor problems or difficulties with organization and layout; especially when there is a time limit in which they have to complete their response. The microcomputer can alleviate the need for handwriting and erasing as well as providing a structure within which the pupil can develop and formulate responses.

(c) Facilitating Motivation

A pupil who is achieving is motivated to achieve even more. If learning disabled pupils have a long history of experiences of failure, they will not be motivated to perform at their best. (Salend, Blackhurst and Kifer, 1982) Diagnostic tests might therefore not give a true reflection of capabilities or deficits thereby resulting in imbalances when the prescriptive programme is designed. The motivational aspects of the microcomputer can help overcome the lack of motivation in the testing milieu. As has already been pointed out feedback and reinforcement can promote motivation. This process is also operative in the testing situation. (Salend, Blackhurst and Kifer, 1982) Tests administered via microcomputer delivery can be programmed to deliver feedback and reinforcement to pupils by presenting certain congratulatory messages on the screen when a particular level of success is attained. Tests can be motivating if they are presented in a game format using where necessary, or if applicable, lots of colour and graphics.

The branching capabilities of microcomputers can foster motivation by doing away with frustration. The branching process permits the teacher to further assess mastery of educational objectives by providing exploration of specific subject matter. Pupils who are coping with level of questioning can be branched to progress at a higher level. Ceilings can also be built into programmes so that pupils who are experiencing continuing failure on the test can have the test stopped. This prevents the "winding down" of motivation by continuing to work at something whilst

experiencing no success. An additional way in which pupils can be assessed is by exposing them to varied ordinary commercial software in order to observe how they tackle the task of interacting with the software.

Lee H. Sissons (1983) has devised a method of evaluating pupils' learning disabilities by allowing them to interact with commercial software, at the same time tempting them to develop a more serious approach to learning. Sissons contends that many of the problems that young pupils with learning disabilities have are at the first two levels of learning, viz. knowledge/memory and comprehension/cognition. The former category consists of perceptual recognition and discrimination (including speed and spatial/temporal processing). This category also includes recall, both long and short-term (including revisualization abilities). The latter category of comprehension and cognition includes understanding, translating and interpreting in one's own words. The input is through the eyes, ears, skin and muscles whilst the output, which is often distorted or missing, involves gesturing, moving, speaking, reading and writing.

Sissons (1983) suggests that many of the diagnostic instruments available today, delivered both via the teacher or microcomputer mode, tend to evaluate complex forms of learning, involving associational processes between several modalities. (Sissons, 1983:3)

Consequently, Sissons maintains, remedial teachers must supplement standardization testing with clinical observations so that information relative to how the pupils learns, where the problems are occurring, and what needs to be done to circumvent them, can be furnished.

Sissons undertook clinical observations with two pupils who had been identified as learning disabled. Prescriptive programmes were designed and the pupils were exposed to commercially available programmes in their particular areas of deficit. Much of the software was in games format. Most proved highly motivational. The feedback that the evaluator obtained consisted of areas where difficulties persisted as well as areas

where there was an ongoing grasping and acquiring of the skill that had been deficient. Strengths were also concentrated on. In each case, via task analysis, additional software could be introduced, and the prescriptive programme redesigned according to the feedback obtained from the microcomputer interaction. Sissons reported that the diagnostic and prescriptive outcome of the clinical observations were successful and this opens the way for similar evaluations of learning disabled pupils in the future. Of one pupil it was observed:

Karla will continue to need help for a long time but she is having successful, positive experience with learning and this is probably the single most important factor in helping a child with learning difficulties to succeed. (Sissons, 1983:6)

It was reported of the second pupil, a boy, who had experienced difficulty with spelling, maths and comprehension:

With this computer-age form of "play therapy", Joey developed strategies for learning to learn. He classified ideas, synthesized new rules and used them to solve problems...he developed the implications of strategies on one programme which he could then try on another. (Sissons, 1983:8)

Sissons contends that many pupils with learning disabilities develop rigid thinking processes. The use of computer games allows them to explore various consequences without the emotional consequences of "real" failure. This could lead to freedom to explore different ways of thinking using higher level associative and integrative processes.

It was reported that "Joey" was able to overcome his fear of failure and expand his experienced by interacting with the microcomputer.

Additional areas of success were achieved with "Joey's" small muscle co-ordination which improved as he learned to monitor his kinaesthetic feedback. Handwriting, too, improved. Probably most important of all, through his success experiences, his self-esteem increased and he began to relate more easily to his peers. With increased confidence, he became less anxious and defensive, and more open to others and their ideas. (Sissons, 1983:8)

7.6 Administrative and Management Applications

The passing of laws in the United States as well as in the United Kingdom in respect of educational practices for learning disabled pupils has, as pointed out, resulted in an enormous amount of additional record keeping. Indeed, the entire new philosophy and approach to the education of pupils with special educational needs is now and in the future going to call upon the administrative expertise of teachers as they are forced to cope with the load of planning, evaluating, diagnosing, record keeping and supervising for these pupils.

As increased time is spent in these administrative tasks, it could lead to less time being available for planning, supervising and teaching.

The various qualities of the microcomputer can provide the remedial teacher with an extremely useful alternative for coping with the administrative demands made on him. Not only can data be maintained and updated more easily on the microcomputer, but in addition the information recorded can be more readily manipulated in order to provide the teacher with useful and timely analysis.

In order to assist special education administrators and remedial teachers in dealing with administrative problems a number of software systems have been developed.

Hagen (1984) describes, briefly, a few of these systems. (Appendix 6)

(a) Accumulator II

This is a management system for special education that allows one to store and retrieve all information for each pupil. The programme may be designed to fit each pupil's needs and allows up to twenty fields for each pupil.

(b) Individual Education Plans (IEP's)

IEP's are generated after a pupil's evaluation. A one-page data sheet is completed with all of the information needed for an IEP.

(c) Special Education Administrative Software

In this package, five programmes may be combined to store data and reports for individual educational plans:

- Date base pupil data and reports
- Conferences, IEP services, etc.
- Due process including referral assessment, reassessment and reports
- A report generator that produces individual and group reports
- Pupil incident system provides reports on pupil incidents.

(d) Special Education Retrieval System

The EPI Retrieval System will allow one to locate, rapidly, educational materials to meet the exact needs of pupils. Approximately 5 000 of the most popular print materials from over one hundred publishers cover pre-kindergarten to adult education perceptual skills, motor skills, readiness, and beginning level of all basic skills. The system also allows one to include one's own materials.

The four administrative software packages mentioned above indicate the level of sophistication to which administrative programmes have been developed.

Behrman (1984) points out these electronic information processing aspects of microcomputers make them powerful and important record-keeping alternatives for special education administrators and remedial teachers. The above programmes are a selection that can form two types of administrative applications, according to Behrman (1984). These are computer managed instruction (CMI) and computer assisted management (CAM).

CMI refers to using the microcomputer to monitor and plan for individual pupils. The types of software here are designed to assist in the decision-making process. Three major types of CMI can be categorized as cluster or mastery learning systems, computerized test scoring and computerized IEP systems.

CAM can be defined as the use of the microcomputer to analyze, manage and report on programmes. CAM systems that can be of particular use to special education administrators and remedial teachers are; data base management, word processing and electronic spreadsheets.

These two types of administrative and management applications are described in more detail below.

CMI, as previously mentioned refers to the use of the microcomputer to keep records, diagnose, score tests, monitor pupil progress and prescribe a programme for a pupil to follow. The basic idea behind a CMI programme is to provide the remedial teacher with the required information about each learning disabled pupil in order to assist the instructional decision-making process and enhance the individualization of instruction.

Cluster or mastery learning CMI systems are criterion-references micro-computer data bases for instructional curricula that permit the monitoring of individual pupil progress. The curriculum is defined as a scope and sequence of instructional objectives stated as behavioural goals or skills. These goal statements are grouped into clusters representing the hierarchy of skills that must be mastered in order to learn a concept. Skill clusters are arranged in strands that represent the major components of a particular curriculum sequence. These strands are then organized into major curriculum domains or goals. The system makes pertinent information about each pupil available to the remedial teacher through a series of reports and allows the teacher to maintain information on each pupil. The following types of reports are usually available through such a system:

- Pupil progress reports
- Enrolment or class reports
- Current assignment report
- Correlation reports
- Survey statistic reports

Cluster or mastery learning CMI systems have as a common element pre-programmed formats for the input of pupil data and for the format of reports. The teacher has a certain amount of flexibility to modify a specific report format within prescribed limitations.

A sphere of CMI which facilitates the work of the remedial teacher is the computerized test scoring system. These systems are available in two types of formats ; scoring services and test scoring computer programmes. Both systems are designed to provide the remedial teacher with criterion-referenced test analysis in order to assist in the diagnosis, prescription and placement of learning disabled pupils.

It will be appropriate to mention and briefly describe some of the more common evaluation devices that are now available via microcomputer software. (Appendix 6)

(a) Diascriptive Reading

A diagnostic, prescriptive, tutorial reading programme covering main data, details, fact/opinion, vocabulary, sequence and inference at levels three to eight. The series contains six diagnostic tests and thirty-six developmental reading programmes. The management system will keep track of the pupil's progress and will remediate or advance the pupil through each skill area without teacher intervention.

(b) O'Brien Vocabulary Placement Test

This is a graded vocabulary placement test that will find a pupil's independent reading level. It is reputedly culturally unbiased and discounts guessing.

(c) Peabody Individual Achievement Test (P.I.A.T.) - Error Analysis Report

Inputting results from the Peabody Individual Achievement Test along with individual information will produce a report containing:

- Pupil background information
- Diagnostic statements indicating level of performance in the five skill areas measured on the P.I.A.T., and
- A set of annual goals and short-term objectives based on the pattern of errors on the P.I.A.T.

(d) Woodcock-Johnson Scoring Programme

This programme is designed for the first time computer operator. Scoring of all twenty-seven subtests takes about ten minutes. Multiple copies of the report can be printed out. The report includes the cluster scoring completed for both grade and age, standard scores completed for both grade and age and functioning level completed for all cluster scores.

(e) WISC-R Computer Report

This programme facilitates report writing of can be used as one component of the report. The WISC-R sub-test scores, VIQ, PIQ, FSIQ, as well as GE scores are entered. Standard scores of reading, spelling and maths from an achievement test of the teacher's own choice are also entered. The result will provide from 70%-90% of the final report.

As with test scoring programmes, there are also now available a number of computerized IEP programmes. The IEP is a crucial aspect of remedial education. Brown (1982) therefore points out that owing to the large number of management systems available, remedial teachers must be careful to select a system which is both efficient and sensitive to the needs of the pupils. Although there are numerous IEP programmes available, Withrow (1973) advises special educators to develop information systems designed around learner needs rather than around the parameters established by the available microcomputers systems. This consideration is particularly relevant when selecting a system that will determine, influence or depict a pupil's educational programme. (Brown, 1982)

Brown (1982) suggests that a microcomputer-assisted IEP generation programme is a good example of a system which must be easy to use and flexible enough to reflect the individual needs of each pupil. The IEP programme must be flexible in order not to inaccurately or inadequately reflect the actual educational programming or dictate a programme that does not meet the pupil's needs. In other words, to be truly effective and useful a computerized IEP system should be sufficiently flexible to allow teachers to address individual pupil's needs and be sufficiently complete to make the IEP process more efficient.

Although IEP programmes are available that address these needs, Brown (1982) describes an interesting IEP project which was designed by special educators and which is sufficiently flexible to meet what he considers to be the crucial requirements of any IEP programme. The project in question was called CAMEO (Computer Assisted Management of Educational Objectives). It was designed to provide remedial teachers with an easy and efficient way to develop and print IEP's while maintaining the flexibility necessary to address individual pupil's needs. CAMEO utilizes computer technology in conjunction with a central resource of several thousand objectives to minimize the preparatory and clerical work involved in IEP development. A field test was carried out with CAMEO in 1981/82. Remedial teacher respondents felt that CAMEO reduced IEP preparation time as well as providing the flexibility necessary to address individual pupil needs. Projects such as CAMEO have paved the way for further development in the sphere of IEP software.

CAM, as pointed out earlier, is a term used to identify microcomputer software that has been designed primarily for administrative and management purposes rather than for instructional management purposes as was the case with the CMI software. CAM software is handy from the point of view that it can be handled by the complete novice. It is more likely that the school secretary rather than the remedial teacher will be involved with interacting with this software. Details from other sources can be handed by the remedial teacher to the school secretary who

can continue with what is required. This is usually the storing and retrieval of statistical data or typing of reports. The CAM applications in this sphere are data base management systems, word processing, and electronic spreadsheets.

Data base management is designed to allow the users to customize and refine their programme by selecting options from a menu. It is a systematic approach to storing, updating and retrieving information stored as data items usually in the form of records in a file. The programmes allow the user to sort records by one or more fields in order to analyze the information contained in a file. The user can design how he wants to report the results of the computer analysis by designating the specific fields to be printed, the order of their presentation, and the records to be included in the report.

Word processing is a valuable microcomputer-based system used for writing, editing and formatting letters and reports. The word processor is a familiar device and those acquainted with it are aware of its capacity for updating, altering, editing and revising documents without manually retyping them entirely. The material can be saved on a disc for a later use. This is useful for the remedial teacher who wants to send out standardized quarterly reports on pupils.

More and more remedial teachers are finding a use for the word processor and it is no longer the exclusive domain of the school secretary.

Electronic spreadsheet microcomputer programmes are another useful adjunct to administration and management. These programmes provide the remedial teacher or special education administrator with the ability to process hundreds of numbers at once, to find patterns, draw conclusions, and explore alternatives suggested by any type of numerical data. They are flexible and versatile programmes that permit the user to explore "what if" alternatives. By changing the variables on the microcomputer, electronic spreadsheets are helpful in solving accounting problems. Other areas where such programmes help are analyzing test scores and projecting enrolments.

Bearing in mind the role of the classroom and remedial teacher, particularly in the management of learning disabilities, it will be perceived that many of the so-called "paper-work" tasks can be dispensed with, and carried out via the sophisticated microcomputer software currently available. This will free the remedial teacher from these tasks, thereby enabling him to give more attention to the pupil in the actual prescriptive or teaching situation.

7.7 Software Evaluation and Selection

The microcomputer, like any other educational aid will only be effective if it really is the best means of achieving the educational objective. Interacting with a microcomputer as an educational aid means interacting with it in terms of both the hardware and the software. Although hardware selection is an important factor to be borne in mind when contemplating the use of a microcomputer, the most crucial variable is the employment of the correct software. No matter how sophisticated the hardware may be, if the software fails to meet the necessary educational criteria and objectives then the whole exercise becomes a futile one.

Hannaford and Sloane (1982) suggest that before employing microcomputers in the education of learning disabled pupils, one must establish whether its use is appropriate.

By appropriate it is also crucial, therefore, to ensure that the software is appropriate. Hannaford and Taber (1982) and Taber (1983) point out that until recently, much of the available software was designed and manufactured by computer programmers, with no educational background, and with even less knowledge of the learning characteristics of learning disabled children. Behrman (1984) points out that although many programmes were technically acceptable they seldom offered materials that utilized the theories and concepts of education that have long been successfully used by educators. It is pointed out, however, that more recently software publishers are becoming aware of the shortcomings in their software and are engaging individuals with the capacity both to

programme and to design software based on sound educational principles.

Dean (1982) and Lambert (1982) state that educators must evaluate software before acquiring it in order to establish its soundness, cost effectiveness, and benefit as a supplement to the existing curriculum. Hannaford and Taber (1982) ask: "Will the benefits gained by the use of the microcomputer software justify the cost of its development or purchase?" Taber (1983) points out that if teachers do not scrutinize the available programmes carefully and at the same time selectively acquire materials of good quality, poor programmes will continue to infiltrate the educational system and this may result in the abandonment of microcomputers as an instructional medium in education.

As Hassett (1984) points out, barely 4% of programmes being published today can really be regarded as excellent in so far that they meet their prescribed educational objectives.

The Educational Products Information Exchange (EPIE) Institute, a non-profit group based at Teachers College, Columbia University, carries out sophisticated and systematic software evaluations. (Hassett, 1984) EPIE states that, "the software packages that now appear on best-seller lists are often very weak in educational terms ; they are however backed by large advertising budgets". EPIE stresses the importance of proper evaluation before purchase. Behrman (1984) points out that many educators have responded to the dilemma by undertaking systematic evaluation of software before purchasing, and have begun demanding excellence in programmes both technically and educationally. This can be seen by the many evaluation devices that are now becoming available.

Taber (1983) suggests that in order for a software evaluation to be effective, it should be conducted in two parts, external and internal. External evaluations involve gathering information from outside the user's environment as to the value of a programme. This may range from referring to software reviews published in educational journals, to acquiring information from teachers in the field who have used the software. Taber (1983) suggests that whenever external evaluations are

considered, a number of questions need to be addressed as to the validity and reliability of those evaluations.

For example:

- Are you considering the same version of the programme that was reviewed?
- Does the evaluator have educational credibility?
- Does the evaluator have technological credibility?
- Is the evaluation limited as to its subjectivity?
- Was the programme considered for an audience with needs similar to the audience for which the programme is intended?
- Was the audience considered in the evaluation similar to the one that will use the programme in the school system?

(Taber, 1983:16)

The internal review requires more time and involvement on the part of the staff who are actually contemplating acquiring the programme, i.e. from within the school. Each piece of available software should be evaluated by potential users.

Hannaford and Sloane (1981) have conducted expensive research into selecting software for learning disabled pupils. They suggest that systematic criteria must be identified that will allow one to select wisely software that meets teacher/learner needs. This criteria also refers to the instructional integrity of the software as well as its technical adequacy and usability. Questions concerning teacher/learner needs focus on appropriate content to meet goals and objectives, and appropriate methods of presentation based on individual learning styles. Questions concerning instructional integrity examine the educational principles upon which the programme is based and the selection of appropriate learning modes.

Evaluation forms need to address themselves to these areas. As mentioned there are numerous ways of evaluating programmes right down to

simple qualitative judgements such as 'good', 'fair', and 'terrible'. Then there are sophisticated devices based on in-depth research into their long-term educational value. Most evaluation instruments are a "variation on a theme". When it comes to evaluating software for learning disabled pupils most compilers of evaluation devices pose similar questions. The evaluation forms are becoming fairly uniform in their approach to seeking adequacy of software for educational use.

It will be appropriate to look at two evaluation instruments. One quite sophisticated and the other slightly less so, but nevertheless designed to meet a specific need.

Taber (1983) describes an evaluation form devised by MCE Inc., which accompanies their software and which is produced primarily for special needs learners. The evaluation form invites purchasers to evaluate their programmes in addition to other microcomputer software not produced by MCE.

The MCE form has been modified to allow the evaluator to compare up to four programmes on one form. Each of the variables listed is rated on a 5-point scale. The scores may be totalled to assist in deciding which of the programmes most closely meets the needs of the evaluator.

The modified MCE Evaluation Form (Appendix 7) is divided into four sections:

- Instructional content
- Educational adequacy
- Technical adequacy
- Overall evaluation

Questions regarding instructional content cover areas such as goals and objectives; data to be used in individualized education programmes (IEP's); prerequisite skills/concepts listed; paraphrasing of or defining of new vocabulary; the documentation or instructional guide and

its value in assisting the instructor in implementing the programme, and other questions regarding the presentation of materials, such as content, type of presentation and concrete examples. The second part of the evaluation form examines educational adequacy. This covers principles based on the educational theory and programme design. The educational theory questions cover the use of reinforcement theory; logical communication between the computer and the pupil; use of music, graphics and other aids that assist in teaching; syllabification of unfamiliar words, sentence length and placement of text on the screen; appropriate programme length, and interest level; and use of branching to individualize to appropriate conceptual and reading levels, as well as breaking the concept into smaller steps.

The section of the evaluation form dealing with technical adequacy concerns questions as to whether the programme is personalized and can be run independently by the pupil. The final section of the evaluation concerns the overall evaluation of the programme; which is the general impression of the product as a whole.

The Microelectronics Education Programme (MEP) in the United Kingdom, concerned with pupils with special educational needs realized the need for properly evaluating both software which was commercially available and that which was being developed by teachers as part of ongoing projects. In assessing the adequacy of these programmes, the MEP highlighted certain crucial questions that should be asked when considering software for learning disabled pupils. Part of the process is also based on the exchange or circulation of software to teachers at a number of schools where it is "tried out" and commented upon. By their own admission the MEP points out that this is not a scientific appraisal but, nevertheless produces interesting views and comments. Programmes are evaluated in the light of a line of questioning, and based on this, an evaluation form has been devised. (Appendix 8)

The MEP (MEP/CET, 1984) suggests that the kinds of questions that need to be asked are:

- What are the educational aims and objectives of the programme, and are they clearly stated?
- For what other teaching objectives might this programme be useful?
- For what age ranges is the programme most suitable?
- Are the identified objectives relevant and worthwhile for the children we are seeking to teach?
- Could those objectives be attained just as well without the computer, using traditional techniques and materials?
- How is attainment of the objectives to be assessed?
- Is the teaching method primarily instructional (involving drill and practice routines or conveying structured information) or is it investigating (proceeding by discovery, with the child uncovering patterns, principles and problem-solving strategies)?
- Is the programme best used for class, group or individual work? And how frequently is teacher intervention required?
- Is the programme accompanied by adequate documentation?
- How flexible is the programme? Does it offer a range of options to cater for a wide range of age and ability levels?
- Will the programme carry the children forward at the right pace, pushing them along, but without stress?
- Is the programme stimulating but exciting and does it adequately reward success?
- Are all messages in short, simple sentences, using everyday words that are likely to be familiar to the children?
- Are the required pupil responses simple?
- Is the programme easy to control?
- Is the programme robust and foolproof?

- Does the programme have a properly thought-out correction and re-trial procedure?
- Does the programme provide for the use of a concept keyboard, light pen or other simplified input device?
- Is the display clear and easy to read?

(MEP/CET, 1984:2-5)

Behrman (1984) refers to five software categories which can be harnessed in dealing with learning disabled and other handicapped users. The first category is the one that has predominantly been referred to in the course of this study. Other categories that need to be considered are: recreational programmes which is an important area of application for pupils with special needs, as it provides the only opportunity for normalized recreation for certain users. An additional category is utility programmes. These are programmes that make existing hardware and software more accessible to handicapped users. For example, altering the way a programme "looks" for pupil inputs may allow switch inputs rather than keyboard inputs. Environmental control or self-help software refers to programmes where the microcomputer is utilized as a tool or assistive device by the handicapped user to perform some skill more efficiently or to provide skills ordinarily unavailable to him or her without the microcomputer. A final category which can be referred to is the one dealing with computer managed instruction and includes the measurement and data base systems referred to earlier which are used for evaluating pupil progress towards stated goals and objectives.

Behrman (1984) states that although each of these categories of software must ultimately have different evaluation criteria, there are some general criteria they must first all meet. The three evaluation areas that are common to all software include the quality of descriptive information, technical soundness and programme flexibility.

Hannaford and Taber (1982) state that there are a number of important considerations that need to be borne in mind when contemplating and acquiring software. Three areas of consideration are suggested:

educational compatibility, instructional design adequacy and technical adequacy.

In respect of educational compatibility, remedial teachers need to select and utilize materials that are appropriate to the needs of the learning disabled child. To this end, the teacher needs to consider cognitive, affective, and sensory/psychomotor dimensions (Hannaford and Taber, 1982)

Cognitively, attention must be given to factors such as the capacity of the learners, their level of performance, their ability to establish and maintain attention, their performance, their learning styles and rates.

In the affective domain considerations such as interest level, motivation, reinforcement and feedback are important. It is also of significance to bear in mind - especially in a country like South Africa, that the material is appropriate for the social and ethnic needs of the group, and whether it provides personalized humanistic instruction.

Sensory/psychomotor needs are also of importance. Sensory and/or perceptual problems may influence the extent to which material presented by microcomputers can be used. It is also important to consider other requirements for interacting with a microcomputer viz. typing ability as well as the ability of the user to discriminate the stimuli presented.

Related to compatibility with the needs of the learners is the compatibility of the needs of the teacher. The software should match with the teachers instructional style and instructional goals. Naturally, as pointed out earlier, the microcomputer software should be compatible with the curriculum. In this respect it should be determined whether the software addresses a "stable" topic or one that rapidly changes. This is to overcome the possibility of the software becoming obsolete before sufficient use has been derived.

Regarding instructional design adequacy, there are certain important

prerequisites that need to be addressed. Most importantly, the material should be built around specific identified goals and objectives. The knowledge and/or skills needed by learners before use of the programme should also have been specified. Depending on the type of programmes, provision for assessing pupil entry level performance and subsequent branching to the appropriate level of content should be present.

Presentation of material is important. Attention must be given to letter size, upper or lower case - depending on the level of user -, clarity and spacing.

Consideration must be given to reading levels. Is the language clear in meaning and free from biases? The teacher must also establish if the stimuli are presented in a manner which makes use of multi-sensory channels such as visual, auditory or haptic.

Important additional considerations in instructional design adequacy are pacing of programmes and branching abilities based on the level at which the pupil is able to cope with the material presented. The pupil's success in interacting with the programme will depend on whether he is obtaining the correct kind of reinforcement and feedback.

It is important that publishers of software bear in mind the capabilities of the microcomputers with which the programmes are going to be used. In other words if the microcomputer has the capability of providing colour, sound and graphics, these features should be included in the programme. This is not to suggest that the programmes should become "gimmicky" in order to "show off" these features, but they should be used discriminately where they enhance the learning process. This is an important aspect to be borne in mind when considering the technical adequacy of software.

Software considerations should also be concerned with establishing whether the programmes are designed to be used in conjunction with peripherals such as printers, light pens, voice synthesizers, paddles

and joy-sticks.

Determining technical adequacy of software also involves determining whether the teacher can "break into" a programme. In the South African context, many programmes are used which emanate from the United States. Often these are "peppered" with American jargon and spellings. These need to be altered or adapted for the local situation. Programmes should be designed to enable the pupil to select "items" or "level" from a so-called menu. He should also be allowed to move to another level or exit the programme depending on help, clues and feedback received from the programme.

A final thought on the technical adequacy of software relates to its "damage-proof" nature for use with learning disabled pupils as well as the necessity for it to be free of "bugs". A "bug" in a programme will create more confusion and frustration for learning disabled pupils than it will for a normal pupil. Programmes with identified "bugs" must be avoided.

The numerous evaluation devices available today address themselves to many of these aspects of software design. It is therefore of benefit to refer to such devices in order to extract the maximum benefit when it comes to making software selections. Behrman (1984) states that in order for the education profession to effect a change in the quality of computer software for use with handicapped users, standards must be set and definitions created to guide the commercial software industry. These ideas must be freely accepted within the profession as well; thereby being adhered to by teachers who intend designing - and possibly ultimately publishing their own software.

7.8 Teacher Training for Microcomputer Use in Remedial Education

As is evinced by the findings in Chapter Six there is an urgent need for special education administrators to address themselves - in South Africa in particular - to the question of pre-service and in-service training for remedial teachers in the use of microcomputers with learning disabled

pupils.

The application of microcomputers in remedial education seems to have been sadly neglected with a move to incorporate this technology only now starting to take off with any significance.

Remedial teaching is a profession which is becoming increasingly popular in South Africa with many new teachers qualifying annually. The skills required by the remedial teacher for the discharge of his task are already quite complex. With increasing emphasis being placed on the incorporation of microcomputer technology in the remedial situation, qualified and trainee remedial teachers will need to learn about these devices as well in order to be able to employ them to accomplish certain educational goals. Without the acquisition of additional skills in this area, the adoption of the microcomputer will be out of the range of many remedial teachers.

Behrman (1984) lists prioritized competencies for computers in special education. These priorities can be categorized as highest, medium and lowest. By initially addressing oneself to the high priority competencies remedial teachers will acquire the basic skills, and motivation, to move onto the other priorities over an extended period of time.

As far as pre-service and in-service training is concerned the following can be enumerated as priority competencies to be acquired:

- (a) Learn to operate a microcomputer, load and run commercially available software.
- (b) Be able to select appropriate software for classroom usage.
- (c) Learn to perform basic utility functions such as formatting discs, copying files, printing, etc.
- (d) Understand the role that the microcomputer has in special education.
- (e) Know the major types of applications of microcomputers in special education, i.e. CAI, CMI, simulations, problem-solving, etc.
- (f) Know related resources and how to obtain access to them.

(Behrman, 1984:182)

On the basis of these points, special educators in education departments at universities and colleges need to consider ways of introducing courses in order to equip remedial teachers with these competencies.

Many universities have computer science departments and the resources there can be used to offer remedial teachers electives in microcomputer use with learning disabled pupils. Ideally, it would be convenient if the education department itself could have its own microcomputer-equipped resource room where remedial teachers who have experience in this technological field, could conduct a course for trainee teachers.

In South Africa trainee teachers at universities usually undertake a single post-graduate year in a department of education. This is usually a crowded year where students are being introduced to the foundations of the educational system as well as being provided with knowledge and skills to teach several academic subjects. Difficulties might be encountered here in attempting to slot specialized micro-computer courses into an already crowded academic year.

Ideally, thought should be given to introducing specialized micro-computer-use electives to longer courses for primary school teachers as well as already qualified teachers who are undertaking a further specialized diploma for working with handicapped pupils. Teacher training colleges are ideal for conducting courses in 'microcomputer use' as trainees here are resident with the same department for up to four years.

Many trainee remedial teachers are likely to enter university or college to undertake a specialized degree diploma with little, if any, familiarity with microcomputers. Besides the new specialized skills they are going to have to acquire, attention will also have to be given to the acquisition of skills in working with microcomputers, as this now appears to be a field where one is confronted with a potentially potent aid in the teaching of learning disabled pupils.

The following section outlines and suggests sample courses that could be introduced at university and college level to assist remedial teachers in acquiring the necessary skills in order to use microcomputers with learning disabled pupils. This pre-service sample programme is based on some of the numerous aspects outlined in this study which appear to be the major issues being addressed regarding microcomputer use in the teaching of the learning disabled.

It is proposed that the course suggested here be conducted by special educationists qualified to do so. This is not to underestimate the competency of staff working in a computer science department at a university or college. This course of action is merely suggested as many computer scientists may not necessarily be in a position to stress the educational aspects of microcomputer use in the classroom.

The sample course outlined here is designed as a six-week block consisting of four hours of lectures a week. Assuming that trainee teachers might spend at least a day a week away from the institution doing teaching practice, the suggested course timetable is designed for four lectures a week of one hour each.

Week	MONDAY	TUESDAY	THURSDAY	FRIDAY
1.	a) Computer Literacy	Computer Literacy	b) Introduction to computer in education	Introduction to computer in education
2.	c) Introduction to	Microcomputers in	Special Education	>
3.	d) Selecting and Evaluating Software			e) Using microcomputer technology to assist the learning disabled
4.	Using microcomputer technology to assist the learning disabled	(f) Teaching computer literacy to learning disabled		g) Programming for the remedial teacher
5.	Programming for the remedial teacher		h) Using LOGO with	learning disabled pupils
6.	Using LOGO with learning disabled pupils		i) Research in Technology and the learning disabled pupils	

Fig. 35 A Six-Week Block of Lectures

7.8.1 Suggested Content of Lecture Segments

(a) Computer Literacy

- What is a microcomputer?
- What are the various parts? How do they work?
- What skills are needed to operate a microcomputer?
- The history and development of microcomputers
- An introduction to programming
- Computer applications in everyday life.

(b) Introduction to Computers and Education

- What are the goals of computers in education?
- When, and when not to use computers in education
- Effects of integrating computer with the curriculum
- Knowledge of hardware, software and computer-related educational materials.

(c) Introduction to Microcomputers and Special Education

- Theoretical basis of microcomputers and special education
- Assessment/Diagnosis of learning disabled pupils
- Preparing IEP's via the microcomputer
- Prescription via the microcomputer, e.g. Maths, language, spelling, using drill and practice, simulation, etc.
- Management and Administration.

(d) Selecting and Evaluating Software

- Workshops to view and discuss pros and cons of commercially available software
- How to use software evaluation devices
- Examining use of sound, graphics, colour in software.

(e) Using Computer Technology to Assist the Learning Disabled

- Acquainting teachers with computer-related educational devices
- Acquainting teachers with peripheral devices and functions thereof; joysticks, voice synthesizers, sound, etc.

(f) Teaching Computer Literacy to the Mildly Learning Disabled

- Content of what is necessary to impart to learning disabled pupil
- How to introduce pupil to basic programming in a structured manner.

(g) Programming for the Remedial Teacher

- Introduction to programming languages
- Workshops to teach fundamentals of programming such as BASIC and PILOT
- Conceptual design of courseware
- Detailed courseware design and development.

(h) Use of LOGO with Learning Disabled Pupils

- Introduction to philosophy of Seymour Papert
- Workshops to interact with LOGO indicating characteristics of programme, and various levels of interaction
- How to use LOGO for problem-solving and evoking appropriate lines of questioning.

(i) Research in Technology and the Learning Disabled Pupil

- Introduction to literature and sources of research
- Benefits of Conferences, workshops, seminars
- Exposition of areas of special education that need to be researched.

In-service training for remedial teachers will be significantly different from pre-service training. This will be obvious from the fact that the workload of in-service teachers will often not permit them the time to undertake courses to the in-depth degree suggested above.

Initially a one-day week-end course can be conducted to introduce teachers to computer literacy and the role of microcomputers in education in general and special education in particular.

Experience has shown that many teachers - remedial teachers included - are ignorant of benefits that might be derived from microcomputer interaction. The prospect of having to face microcomputers is sometimes a daunting experience.

During a day-long or week-end workshop remedial teachers could be introduced to some of the very "inviting" aspects of microcomputer applications such as wordprocessing. Most individuals have used a typewriter and interacting with a wordprocessing programme will not be very threatening. Remedial teachers could then be asked to observe the workings of an IEP programme. The possibility exists that when the teachers see the benefits that can be derived from using such software, they might be motivated to undertake further exploration.

Hopefully, once the enthusiasm is aroused, ongoing workshops can then be conducted to expand their knowledge and skills in spheres already mentioned as part of pre-service training. These can be conducted on an ongoing basis.

The teachers should be encouraged to use the hardware and software already available at the schools where they teach. Other special educationists and remedial teachers can be invited to schools to share knowledge.

Ideally, the situation will eventually evolve where workshops can be arranged for all the remedial teachers in a particular area. These can be arranged and conducted by teachers with "know-how" and experience who want to share this knowledge. Eventually a teachers' centre with an established microcomputer resource room can conduct courses or send out lecturers to a centralized venue to do so. The teachers' centre, of course, would be ideal for such in-service course as it would possess the resources for lectures, discussions, demonstrations and "hands-on" practice with appropriate hardware and software.

7.9 Findings

Research writings and practical applications offer considerable evidence to suggest that the microcomputer presents as a potentially dynamic tool in the diagnostic, prescriptive and learning process of learning disabled pupils. This role can also be extended to management and administrative processes.

Children with learning disabilities, be they specific or general, suffer from a lack of communication and interaction with their environment. This restricted communication serves to limit the pupil's access to knowledge, thereby limiting his or her ability to relate to, make sense of, and gain from incoming information.

The microcomputer is one of the great technological advances of the so-called 'information age' and educational theorists have perceived a valuable role for it in the transfer of information and knowledge.

Special educationists have realized the potential of the microcomputer for the unique needs of learning disabled pupils and to this end much research has been undertaken in order to determine the best way to harness this device to meet the very special needs of these pupils.

Past research and applications, and current developments and trends have led theorists to conclude that the microcomputer has very definite benefits for the learning disabled pupil. These can be enumerated as follows:

- (a) Microcomputers are "user-friendly" by providing pupils a non-threatening environment in which to work; Especially where other methods of instruction have been unsuccessful.
- (b) The microcomputer allows pupils with learning disabilities to work at their own pace in small steps in a private environment where their being slow doesn't create embarrassment.
- (c) The microcomputer does not get bored. It is patient and will give the learning disabled pupil undivided attention for as long as he wants it.

Together with the motivational aspect of microcomputer interaction there seems to be sufficient evidence to conclude that the microcomputer is a potentially valuable remedial tool. The value of this device can also be extended to the sphere of management and administration where it can drastically cut down on the teacher's time spent on so-called "paper work".

However, on the basis of proven success in various aspects of the field, remedial teachers must be wary of jumping on the bandwagon to embrace this technology. It is not to be regarded as the 'panacea' to those unsolved problems and stubborn remedial cases. Its introduction into the remedial classroom must be undertaken with caution and circumspection. There is an old adage which states: "A little knowledge is a dangerous thing". In the same way that there are proven benefits there are also certain pitfalls that require attention.

Programmes and ongoing research projects such as those of SRA Technologies and MEP are serving to throw light on developments as well as opening the way for further knowledge and applications. Individuals in the field need to look to those sources for guidance.

A crucial area that still needs attention is that of the software domain. Attention must still be given to the multisensory approach to learning which is ideal for learning disabled pupils. Software should make use of this approach as it will be more valuable for the pupils. Readability of software, and appropriate mode of presentation still needs to be adequately addressed. An additional aspect of software development must consider the curriculum and the extent to which the software integrates sufficiently. Instructional fragmentation must be eliminated. In this respect closer liaison will be required between educationists and computer programmers.

It is highly commendable that programmes and projects in the United Kingdom and the United States have been established to tap all resources, develop guidelines, and make recommendations for implementation of microcomputer applications in remedial education. Remedial education has for long been

the poor relation of the educational system with authorities usually attempting to serve learning disabled pupils within mainstream education without the necessary attention and resources required for the special needs of this category of pupil. At last moves are being made to address the special needs of these pupils within the framework of an exciting new technology available to educators.

Unfortunately, as is evinced from this study, there are tremendous shortcomings within the South African context.

Besides recommendations suggested by the H S R C study, no formal policy has been spelt out in respect of microcomputer use in remedial education. Schools and educational institutions are left to their own devices and appear to be foundering. No lead has been taken by educational authorities at central or local government level. If the situation in the Cape Peninsula is indicative of the national situation, then the first steps have barely been taken in addressing the role of the microcomputer in remedial education. As is evinced by the survey undertaken, universities and colleges have not considered the situation in any depth - if at all. Educational clinics have not given attention to the situation either. It has been left to a very small dedicated band of individuals in the schools to embrace the microcomputer for remedial purposes. Although highly commendable, such teachers, by their own admission are aware of the shortcomings and dangers inherent in not having sufficient guidance in doing so. The movement - still very much in its embryonic stage - is unco-ordinated.

Remedial teachers recognize the potential of the microcomputer and are prepared to utilize it if it can be found to be a valuable and worthwhile tool. It needs an individual educational institution or the educational authorities to take the lead.

Almost universally, the benefits of microcomputer use in education are being accepted. The acceptance is no less applicable in remedial education as pointed out in this study.

It seems evident, therefore, that there is tremendous scope for micro-computer use in remedial education but the real potential of these devices will only be achieved when a co-ordinated lead is taken by those in the profession who know what they need to teach, and who can do this in conjunction with computer scientists and computer developers.

Remedial teachers must become involved in this new technology in order to prevent others usurping their instructional role. It is the responsibility of remedial teachers to ensure that this new technology is not assigned to the rubbish heap because of ignorance or indifference. This new technology has an opportunity to play a major role in the prescriptive and learning process of the learning disabled. It is almost ideally suited to do so. It must be given the chance.

Behrman (1984) quotes Dewey: "The purpose of education is to enable a person to come into possession of all his powers".

The microcomputer role here is inestimable. It deserves our attention not only for the purpose of our own professional growth but for the potential benefit of those pupils we love and to whom we have dedicated ourselves professionally.

7.10 Recommendations

In the light of conclusions and findings reached in this study, the following recommendations are suggested for the development and extension of a programme for microcomputer use in remedial education in South Africa.

- (a) An organization should be established along the lines of the Microelectronics Education Programme in England. Such an organization could draw on the experience gained there, but adapted here for local conditions. The organization would serve to establish regional workshops to develop and evaluate software, to disseminate information in respect of microcomputer use in remedial education and to assist schools in setting up microcomputer departments for remedial education.

Education authorities, psychologists in charge of clinics, instructional leaders in schools and remedial teachers should serve on the executive of, and become involved in, such an organization.

- (b) Either as an integral part of the programme suggested above or separately, pre-service and in-service courses in respect of micro-computer use in remedial education should be introduced. If undertaken outside the boundaries of the programme suggested above, the lead should be taken by universities, colleges and teachers' centres.
- (c) Universities and colleges must introduce pre-service training in microcomputer use for trainee remedial teachers.
- (d) Schools should subscribe to reputable software directories or make sure that they have access to relevant literature in order to be aware of current software available for remedial use.
- (e) Schools must make at least one microcomputer available for exclusive use by the remedial teacher. The microcomputer must be kept in a remedial resources room.

8. GLOSSARY OF COMPUTER-RELATED TERMS

ANIMATION The process whereby the computer repeatedly plots a picture on the screen so that the impression of movement of the picture is given.

ARTIFICIAL INTELLIGENCE Some computer programmes perform tasks in such a way that if a human were to do the same thing, their behaviour would be described as intelligent. For example, programmes can 'learn' from experience, play championship chess, converse in 'natural-sounding' English, prove theorems in geometry.

BASIC Beginners All-purpose Symbolic Instruction Code. A language which converts the instructions contained in the programme to a form which the computer can read and obey. It is the most widely used language for micro-computers.

BUG An error in a programme or, more generally, in the logical processes leading to it.

BYTE A unit of memory in which the computer can store one character, or piece of information. Thus a computer with 32K bytes of memory can store 32,000 characters.

CHIP A small piece of silicon on which has been printed an integrated electrical circuit capable of processing and/or storing information. Its small size has enabled microcomputers to be developed.

COMPUTER-AIDED (or ASSISTED) INSTRUCTION (CAI) Where computers are used to guide the user through a prescribed course of learning and testing. The computer assumes the role of teacher, asking questions and assessing the user's responses.

COMPUTER-ASSISTED (or AIDED) LEARNING (CAL) Where teaching and learning in any part of the curriculum are aided by some application of the computer. The role of the computer can be as a teaching aid, or it can be more student-centred. The latter approach is becoming more significant with the spread of microcomputers.

COMPUTER-MANAGED LEARNING (CML) The use of the computer to monitor, analyse and report on student's learning in an individualized curriculum.

COURSEWARE Educational material comprising software and documentation.

CURSOR A symbol (sometimes flashing) which appears on the screen to show where the next character put in to the keyboard will appear.

DATA Information; especially information that can be processed by the computer.

DEBUG The process of removing bugs (errors) from programmes. Seymour Papert and others have drawn attention to the heuristic value of debugging as a process which helps in problem solving.

DISC DRIVE A device which enables the computer to store and retrieve information on disc. Disc drives may be single-sided or double-sided and can 'read' and 'write' information in varying densities.

FLOPPY DISC A thin flexible disc, coated with magnetic particles, used to store data and programmes. It is contained within a protective paper sleeve within which it revolves.

GRAPHICS Computers can draw pictures and diagrams as well as text on the screen.

HANDS-ON The direct interaction with the computer by the user, normally by means of the keyboard.

HARDWARE The computer equipment and its associated peripherals which comprise a computer system.

INTERFACE A piece of equipment which enables computers and/or peripherals to be connected to each other.

KEYBOARD A set of keys, similar to those on an electric typewriter, which enables the user to communicate directly with the computer.

LIGHT PEN A pen-like device which can be pressed against the screen to provide input without using the keyboard. The computer can detect what the pen is pointed at so the user can choose an option from a list or enter a shape.

MAINFRAME A large multi-purpose computer, usually serving the needs of a large community of both local and remote users. Each user communicates with the computer either through a time-sharing terminal or through a batch-processing system.

PERIPHERALS The 'plug-in' components which enable a computer to receive, store and transmit information. The more common peripherals are a visual display unit, printer and disc drive/cassette drive.

PLATO (Programmed Learning At a Terminal On-line). A CAI system and author language developed at the University of Urbana-Champaign, Illinois and by Control Data Corporation. It is very powerful but has so far only been available on expensive hardware.

RAM (RANDOM ACCESS MEMORY) That part of the computer's memory which stores programmes and data temporarily. The information is erased when the power is switched off.

ROM (READ ONLY MEMORY) Memory which can only be 'read' not 'written on'. It is used to store programmes which are used frequently, or which are needed before other programmes can be implemented. ROM can be plugged in a computer and is sometimes used as a way of distributing programmes (especially games).

TERMINAL A piece of equipment containing a keyboard with a printer and/or a visual display unit, which enables the user to communicate with a computer. The terminal may be distant from the computer.

USER-FRIENDLY Describes an interactive programme which gives helpful and informative messages to guide the user. More generally used to describe any computer software, system or environment which is friendly and accessible to the user.

VISUAL DISPLAY UNIT (VDU) A television-like screen, (black and white or colour), which displays the output of the computer.

WORD PROCESSING A powerful technique for editing, storing and rearranging text. The text is stored magnetically until it is ready for the final Print-out. Word processing can be performed either by a dedicated word processor (purpose built) or by general-purpose computers. Although Microcomputers can be used for word processing, a disc-based system is almost essential.

APPENDIX I

District Characteristics

Abingdon School District

- a. Abingdon, Virginia
- b. Southwest Virginia (9th District)
- c. Suburban/Rural
- d. Lower and middle
- e. 8,800 (stable)
- f. Predominantly White

Hopkins School District

- a. Hopkins, Minnesota
- b. Minneapolis area (3rd District)
- c. Suburban
- d. Middle
- e. 6,900 (slightly declining)
- f. Predominantly White

Pittsburg School District

- a. Pittsburg, California
- b. East Bay area (7th District)
- c. Suburban
- d. Middle and lower
- e. 6,000 (stable)
- f. Mixed

Boise School District

- a. Boise, Idaho
- b. Southwest Idaho (1st & 2nd Districts)
- c. Urban/suburban
- d. Middle
- e. 21,000 (stable)
- f. Predominantly White

Lexington Regional District

- a. Lexington, Massachusetts
- b. Boston area (7th District)
- c. Suburban
- d. Upper middle
- e. 1,250 (stable)
- f. Predominantly White

Prescott School District

- a. Prescott, Arizona
- b. Near Phoenix (3rd District)
- c. Suburban/rural
- d. Middle
- e. 4,450 (stable)
- f. Predominantly White

Cheyenne School District

- a. Cheyenne, Wyoming
- b. Southeast Wyoming (At Large)
- c. Urban/rural
- d. Middle
- e. 13,000 (stable)
- f. Predominantly White

Linden School District

- a. Linden, Michigan
- b. Flint area (7th District)
- c. Suburban/Rural
- d. Lower middle
- e. 2,500 (slightly declining)
- f. Predominantly White

Shelby School District

- a. Shelby, Ohio
- b. North Central Ohio (4th District)
- c. Suburban/rural
- d. Middle
- e. 2,800 (stable)
- f. Predominantly White

Commack School District

- a. Commack, New York
- b. Long Island (3rd District)
- c. Suburban
- d. Upper middle
- e. 9,200 (declining)
- f. Predominantly White

Oakhurst School District

- a. Oakhurst, New Jersey
- b. New Jersey Coast (3rd District)
- c. Suburban
- d. Upper middle
- e. 4,150 (declining)
- f. Predominantly White

Tallulah School District

- a. Tallulah, Louisiana
- b. Near Jackson, Miss (5th District)
- c. Suburban/rural
- d. Lower
- e. 3,800 (slightly declining)
- f. Predominantly Black

LEGEND: a. City, State	d. Income Level
b. Location (and Congressional District)	e. Student Population (and Trend)
c. Suburban/Urban/Rural	f. Ethnic Composition

DRAFT LETTER TO UNIVERSITIES (FACULTY OF EDUCATION)

Stuart I. Robinson,
P O Box 11309
Vlaeberg
8018

1985-05-01

The Dean
Faculty of Education
ABC University
XYZ Town
0001

Professor,

MICROCOMPUTERS IN REMEDIAL EDUCATION

I am currently engaged in researching the role of the microcomputer in remedial education. I am registered at the University of Cape Town; Division of Specialised Education in the Faculty of Education.

I should appreciate it if you could advise me as to whether you have included in your curriculum for trainee remedial teachers an elective dealing with the use of microcomputers as a diagnostic, prescriptive or management instrument in the teaching of specifically learning disabled pupils.

Further, I should appreciate it if you would advise me of any other work you might be doing in this field.

All information will be dealt with in the strictest confidence.

Yours faithfully

Stuart I. Robinson

DRAFT LETTER TO SCHOOL CLINICS

Stuart I. Robinson
P O Box 11309
Vlaeberg
8018

1985-05-01

The Head
ABC Clinic
XYZ Suburb
0001

Sir

MICROCOMPUTERS AND REMEDIAL EDUCATION

I am currently engaged in researching the role of the microcomputer in remedial education. I am registered at the University of Cape Town; Division of Specialised Education in the Faculty of Education.

I should appreciate it if you could inform me briefly of the extent, if any, of microcomputer applications at your clinic, particularly in diagnosing, prescribing and managing pupils with specific learning disabilities.

Should you be utilising microcomputers in any of the above spheres, I should appreciate it if you would indicate whether I might observe the work being done.

All information received will be dealt with in the strictest confidence.

Yours faithfully

Stuart I. Robinson

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APPENDIX IV

DRAFT LETTER TO SCHOOLS FOR THE SPECIFICALLY LEARNING DISABLED

Stuart I. Robinson
P O Box 11309
Vlaeberg
8018

1985-05-01

The Principal
ABC School
XYZ Town
0001

Sir

MICROCOMPUTERS AND REMEDIAL EDUCATION

I am currently engaged in researching the role of microcomputers in remedial education. I am registered at the University of Cape Town; Division of Specialised Education in the Faculty of Education.

I should appreciate it if you would inform me briefly of the extent, if any, of microcomputer applications at your school, particularly in diagnosing, prescribing and managing pupils with specific learning disabilities.

All information received will be dealt with in the strictest confidence.

Yours faithfully

Stuart I. Robinson

DRAFT OF LETTER ACCOMPANYING QUESTIONNAIRE

Stuart I. Robinson,
P.O. Box 11309,
Vlaeberg
8018

1985-07-12

The Principal,

Sir/Madam,

MICROCOMPUTERS AND REMEDIAL EDUCATION

I should appreciate it if you would assist me with some research by having the enclosed questionnaire completed. The questionnaire should preferably be completed by the remedial teacher on the staff, but failing him/her, by the principal.

The research has been approved by the Cape Dept. of Education subject to the following conditions stated in their communication to me (Ref L15/73/7; Mr. G.J. Swanepoel.

- (i) No teacher or principal is obliged to co-operate in this research in any way.
- (ii) No teacher/principal/school may be identifiable in any way.
- (iii) All arrangements for the research will be undertaken by myself.
- (iv) The research must not be conducted during the 4th term of the school year.

Should you wish to assist me with the research, I should appreciate it if you would return the completed questionnaire in the envelope provided by 15 August 1985.

Thank you for your co-operation.

Yours faithfully,

Stuart I. Robinson

APPENDIX VIAddress List of Suppliers of Software Listed in Chapter Seven

- (a) Accumulator II
Southern Microsystems for Education
P O Box 1981
Burlington, NC 27215
- (b) Diascriptive Reading:
Educational Activities, Inc
P O Box 392
Freeport, NY 11520
- (c) Individual Educational Plans
Learning Systems
P O Box 15
Marblehead, M A 01945
- (d) O'Brien Vocabulary Placement Test
Educational Activities, Inc
P O Box 392
Freeport, NY 11520
- (e) P.I.A.T Error Analysis Report
Southern Microsystems for Education
P O Box 1981
Burlington, NC 27215
- (f) Special Education Administrative Software
Sysdata International, Inc
7671 Old Central Avenue NE
Minneapolis, MN 55432
- (g) Special Education Retrieval System
Learning Well
200 South Service Road
Roslyn Heights, NY 11577
- (h) WISC-R Computer Report
Southern Microsystems for Education
P O Box 1981
Burlington, NC 27215

(i) Woodcock-Johnson Scoring Programme

Sysdata International, Inc
7671 Old Central Avenue, N E
Minneapolis, MN 55432

APPENDIX VII**Modified MCE Program Evaluation Form.**

DIRECTIONS: This evaluation form is designed to evaluate four software programs. Answer each of the questions about each program you evaluate. Use the following rating scale:

- 3 = EXCELLENT
- 2 = ABOVE AVERAGE
- 1 = AVERAGE
- 1 = BELOW AVERAGE
- 5 = POOR

After rating programs in each area, add up the total scores and place them in the appropriate spaces. Let this rating help you in your decision making in the purchase of microcomputer software.

**NAMES OF PROGRAMS
EVALUATED:**

**TYPE OF PROGRAM
EVALUATED**
(i.e., tutorial, etc.)

- | | |
|----------|-------|
| 1. _____ | _____ |
| 2. _____ | _____ |
| 3. _____ | _____ |
| 4. _____ | _____ |

COMMENTS ON EACH PROGRAM:

- | | |
|----------|-------|
| 1. _____ | _____ |
| 2. _____ | _____ |
| 3. _____ | _____ |
| 4. _____ | _____ |

PROGRAM CHOICE (if applicable): _____

Continued on next page.

PROGRAM NAMES

	1	2	3	4
I. INSTRUCTIONAL CONTENT				
1. Is the content consistent with the goals and objectives of the program?				
2. Is the program one of a series in which carefully planned learning objectives have been followed?				
3. Does the Instructional Guide provide information, suggestions, and materials to assist the teacher in successfully implementing the program?				
4. Are program goals provided that are usable for individualized education programs?				
5. Are evaluation materials and or criteria provided that are usable for individualized education programs?				
6. Are prerequisite skills, vocabulary, and concepts determined and presented?				
7. Is vocabulary defined or paraphrased in text or in the prerequisite skills portion of the Program Principles Section of the Instruction?				
8. Are diagnostic or prescriptive procedures built into the program?				
9. Does the text follow established rules for punctuation, capitalization, grammar, and usage?				

Instructional Content con't.	PROGRAM NAMES			
	1	2	3	4
10. Are supplemental materials provided for learner and teacher?				
11. Is the product designed for appropriate age and ability groups?				
12. Is the program compatible with the curriculum?				
13. Is the program compatible with the needs of the teacher?				
14. Is the content accurate and complete?				
15. Are examples provided with directions when appropriate?				
16. Are redundancy and drill used effectively?				
17. Is language appropriate in tone and selection?				
18. Are concrete applications for concepts provided?				
19. Is feedback immediate?				

II. EDUCATIONAL ADEQUACY

1. Is instructional design of high quality using accepted learning theory?				
2. Are learners always the target of interaction with the computer—a personalized element?				
3. Are positive responses reinforced?				
4. Are frames that follow incorrect responses nonpunishing?				

Educational Adequacy con't.	PROGRAM NAMES			
	1	2	3	4
5. Is reinforcement variable and random in context and established by behavior management principles?				
6. Is branching used where the learner demonstrates need for further concept development before proceeding?				
7. Are avenues of communication from the learner to the computer logical and at comprehensible levels?				
8. Is evaluation of each concept appropriate and sufficient?				
9. Are concepts and skills task analyzed into appropriate steps?				
10. Are color, graphics, and animation used effectively to enhance the lesson?				
11. Are sound, inverse print, etc., employed for attention and reinforcement purposes and not distracting?				
12. Is syllabification provided for new and/or unfamiliar words?				
13. Is sentence length dependent on need and learner levels?				
14. Is the learner always provided with frames that allow for progression through the program?				
15. Does the program provide suitable directions for the learner?				

III. TECHNICAL ADEQUACY	PROGRAM NAMES			
	1	2	3	4
1. Will the program run to completion without being "hung up" because of unexpected responses?				
2. Are the programs difficult or impossible to be inadvertently disrupted by the learner?				
3. Can learners operate the programs independently?				
4. Is the amount on each frame appropriate?				
5. Is the length of each section appropriate?				
6. Are words and lines spaced for ease of reading?				
7. Is variation of type and organization of textual materials appropriate for a clear presentation?				
8. Are inappropriate responses considered and handled appropriately?				
9. Is the educational technology (i.e., microcomputer) the best available for presenting this subject matter?				
10. Are backups available?				
IV. OVERALL EVALUATION RATING OF PROGRAM IN ITS ENTIRETY				
TOTAL FOR EACH PROGRAM				

APPENDIX VIII**Software Review Sheet**

1. Title of package
2. Authors/Publishers

EDUCATIONAL ASPECTS

Please tick

3. How would you classify the program? Mainly:-

INSTRUCTIONAL (e.g. drill and practice routines, or
information in structured form)

DISCOVERY (i.e. program designed to reveal
principles, patterns or problem-solving
strategies by pupil/machine interaction)

OTHER.

4. Is it best used with:-
- | | |
|---------------------------|-------|
| individual pupils | |
| small groups (up to 3) | |
| larger groups (4 or more) | |

5. How often does the teacher
need to be involved?
- | | |
|-------------------------|-------|
| continuously | |
| frequently | |
| once or twice a session | |

6. For what age ranges is
the program best suited?
- | | Interest
age | Reading
age |
|---------|-----------------|----------------|
| under 7 | | |
| 7 to 11 | | |
| over 11 | | |

7. For what teaching objectives (irrespective of the skill areas for
which it was intended) did you find the program useful?

.....

.....

- 8. How far do you consider the program helped the children?
 - A lot
 - A little
 - Not at all
- 9. Did the program offer a correction and retrial procedure?
 - Yes
 - No
- 10. Did the children enjoy the program?
 - Yes
 - No

TECHNICAL ASPECTS

- 11. Were there any practical difficulties in using the program?
 - Yes
 - No

If yes, please specify

.....
.....

- 12. Was the documentation adequate for your needs?
 - Yes
 - No

- 13. Was there sufficient flexibility and a wide enough range of options?
 - Yes
 - No

If no, please comment.

.....
.....

GENERAL

- 14. Please add any other comment not covered above.

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

Teacher.....School.....Date.....



Mr S.I. Robinson
P.O. Box 11309
VLAEBERG —
6018

TELEKS
TELEX 522368

TELEGRAM EDUCATION

TELEFOON
TELEPHONE 45-9329

NAVRAE
ENQUIRIES Mr G.J. Swanepoel

VERWYSING
REFERENCE L.15/73/7

DATUM
DATE 28 June 1985

Dear Mr Robinson

MICROCOMPUTERS IN REMEDIAL EDUCATION: M.ED. THESIS

1. Your letter of 23 June 1985 has reference.
2. Your application is granted subject to the following conditions:
 - 2.1 No teacher/principal/rector of a teachers' college/head of a clinic is under any obligation to co-operate in your research in any way.
 - 2.2 No teacher, principal /rector of a teachers' college/head of a clinic or school may be identifiable in any way.
 - 2.3 All arrangements regarding your project must be undertaken by yourself.
 - 2.4 The research must not be conducted during the fourth term of the school year.
 - 2.5 The conditions 2.1 - 2.4 above must be quoted in full when you approach the principals/rectors of teachers' colleges/heads of clinics for their co-operation.
 - 2.6 A copy of your application requesting the principals/rectors of teachers' colleges/heads of clinics for their co-operation must be forwarded to the Education Bureau (vide address in 2.7 below) before the principals/rectors of teachers' colleges/ heads of clinics are approached for their co-operation.

2.7 A copy of your thesis must be submitted to each of the following:

(a) The Education Bureau, and

(b) The Education Library

of the Cape Department of Education, P.O. Box 13,
CAPE TOWN 8000.

3. The Department wishes you every success.

Yours faithfully

for DIRECTOR: EDUCATION

APPENDIX XPublishers of Software Quoted as Examples in Body of Dissertation

- (a) Meteor Multiplication Academic Skill Builders
Developmental Learning Materials
One DLM Park
Allen, TX 75002
U.S.A.
- (b) LOGO
Logotron Ltd
Ryman House
59 Markham Street
London, SW3
England.
- (c) COMPU-SPELL
Edu-Ware Services, Inc
P O Box 22222
Agoura, CA 91301
U.S.A.
- (d) WORDWISE
Computer Concepts
16 Wayside
Chipperfield
Herts WD4 9JJ
England.
- (e) ANIMAL
Tecmedia Ltd
5 Granby Street
Loughborough
Leics LE11 3DU
England.
- (f) TREE OF KNOWLEDGE
Acornsoft Ltd
4a Market Hill
Cambridge CB2 3JN
England
- (g) ODELL LAKE
MECC Publications
2520 Broadway Drive
St Paul MN 55113
U.S.A.

(h) OREGON TRAIL

MECC Publications
2520 Broadway Drive
St Paul MN 55113
U.S.A.

(i) GEOGRAPHY SEARCH

McGraw Hill Book Company
School Division
Princeton Road
Highstown NJ 08520
U.S.A.

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