COMPUTER AWARENESS AND ITS IMPLEMENTATION AND EVALUATION
IN A SCHOOL COURSE

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Thesis submitted for the degree of PhD of the University of Surrey
This work started as a protest against the view that popular education about computers has to be watered down versions of computer science. The author took it upon himself to investigate other possibilities. Starting from first principles the idea of Computer Awareness was developed and implemented for schools. The following account is a brief resume of the processes developed to achieve this. Computer Awareness is defined as "The possession of sufficient knowledge to enable inferences, general and social, to be made on the basis of what is seen or heard about computers". The three main challenges thrown at the author through the early period of his effort were:

(i) You cannot define Computer Awareness in terms suitable for teaching practice.

(ii) Even if you can define it so, you cannot develop suitable material to teach it, and

(iii) Even if you develop the material, you cannot be sure that you have succeeded.

The account of how the author attempted to meet these three challenges is given in the three parts of the thesis, the Definition, the Implementation, and the Evaluation of a course for Computer Awareness.
The author is grateful to British Petroleum for a Research Fellowship lasting some five years, which enabled him to carry out the work described in this thesis.

He is indebted to Professor L. R. B. Elton for patient understanding and guidance through the duration of this work.
# IN A SCHOOL COURSE

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Apart from the main body of workers in the field of educational research and development, there are many who devote a considerable amount of time and effort in the background to make this activity possible. Whereas the effort made by the main workers is often acknowledged in academic and other published material, it is rare that the contribution made by the background workers is even mentioned. That the role played by these workers in creating an environment to enable resources to be made available for the research and development to take place is critical, there can be no doubt.

One such worker is Jim Ball. His tireless efforts to enable many educational workers to carry out and conclude their work, his support and guidance during difficult periods and his devotion to educational causes are appreciated by all those who know him. To acknowledge his work, in a small way, this thesis is dedicated to

Mr. C. M. Ball
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PART I

The Definitions

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# Chapter 1

## Computer Education for All

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CHAPTER I

COMPUTER EDUCATION FOR ALL

1.1 The State of the Art

Throughout the 1960's various efforts were made to introduce computer education into schools. Computers were new at that time and computer education came to mean many things to many people. Computer Education appeared as 'Computer Appreciation', 'Computer Studies', 'Computer Science', 'Computer Programming', 'Computer Logic', 'Computer Hardware', 'Computer Applications', 'Analogue Computers', etc.

At this time there was a general feeling that "there is a need for all children to know something of the nature and use of computers in modern society" (BCS 1970). Since the subject was at the innovation stage each approach to teaching about computers was determined by the background of its advocates. In retrospect it is obvious that although there was an agreement that something should be taught there was confusion as to what form this should take.

It is reasonable to assume that the movement took a definitive direction in 1969 with the publication of the following two documents:


(b) A report "Computers and the Schools" was prepared by the Scottish Education Department under the chairmanship of B. T. Bellis in 1969 (Bellis B. T., 1969).

Both the papers agreed that a basic course on Computer Appreciation or Studies be provided for all or for a great majority of children in schools. The following topics are common to both the recommendations:
(a) Structure of a computer  
(b) Applications of computers  
(c) Organisation and presentation of information  
(d) Historical development of information processing devices  
(e) Personnel associated with computers  

In addition to these topics the Scottish report included "Why do we need computers?", and the British Computer Society paper included the social impact of computer applications. The Scottish report suggested simple programming by children, while the British Computer Society paper recommended that the computer programming be left out altogether in the introductory course. The British Computer Society, however, did go on to suggest that further topics such as computer programming, numerical methods, statistics, management science, etc., might be included for more able classes.

A number of other events took place around that time which signalled the arrival of computer education in schools. First, "Computer Education" started publishing formally in February 1969 (BCS 1969). Secondly, ICL/CES (International Computers Limited, Computer Education in Schools) took over a project (Computer Education in Schools) from the Hoskyns Group (COMP. ED. 1969), and published the material in the form of a package called "Fundamentals of Computing" (ICL/CES 1969) intended for the majority of children in schools. Thirdly, the National Computing Centre published a package called "Computers and their Impact on Business and Society" as a computer appreciation course in 1970 (NCC 1970). Although a number of books were available before then, they were mainly written for literate laymen rather than specifically for children.

These events are significant not only because they took place within months of each other but also because of the influence they exerted on the direction which this discipline subsequently took. These documents are remarkable also because of the general agreement in them about who should be given Computer Education and what should be taught.

Regarding who should be taught the general opinion seems to be that a great majority of children, if not all, should receive some kind of Computer Education.
However, none of the documents made any attempt to state clearly the general aims of such a Computer Education. The main theme seems to be that "all children leaving school today should have some understanding about computers and computing, and that they should have had the opportunity to experience the power of using a computer whilst at school" (ICL/CES 1969). "Computer Education would seem to begin, therefore, with an appreciation of the immense power and capabilities of a computer and also of its limitations and its complete dependence upon human intelligence and co-operation" (HMSO 1971).

It is obvious that emphasis was placed on understanding the working of the machine and using it. However, some mention was made of the place of the computer in society. "The aim is to help teachers, with any subject background, to present a balanced view of what a computer is and how it can be used and also to set the pupils thinking about what it means - hence the overall title - "Computers and their Impact on Business and Society" (NCC 1970).

The lack of clarity in the statement of aims was partially rectified by D. Conway, Secretary, Computer Education Group, in his opening address "The State of the Art" to the British Computer Society conference on Computer Education in Schools in 1972. He stated that "the most important type of course is the general appreciation course aimed at the whole population. Such a course is designed to educate the future users of computer systems and to make sure that the human elements of large scale information processing systems will be active. At the present time most of the major problems, both political and technical, arise as a result of people's ignorance and fear. The country's future economic well-being depends on our exploitation of computers and thus it is important that everyone can play an active rather than a passive role" (Conway D. 1972).

It is reasonable to seek further clarification of aims from the syllabi and the courses which accompanied the cited literature. All of them have a strong computer science content. At the secondary level computer science may be understood to mean the study of computer hardware and software. In fact the ICL/CES book "The Fundamentals of Computing" is entirely devoted to computer science. Both the "Computer Education for All" paper and the National Computing Centre package "Computer Appreciation in Schools" contain Information Processing; The Structure of a Computer and how it works; Algorithms; Flowcharts and Programming.
They also discuss, with slightly less emphasis, the social implications of computers. The teaching time allocation for computer science topics in the National Computing Centre package is 91 hours and that for social implications is 10-15 hours.

Out of the seven syllabi for CSE Mode II in Computer Studies investigated by Working Party 4 of the British Computer Society, four were found to be based on "Computer Education for All", one on the National Computing Centre package and one on the ICL/CES package. The seventh, that submitted by Llanells' Technical College of behalf of eight schools in the area, is entirely computer science and programming (BCS 1971).

It seems that computer science albeit at a low level is being advocated as the Computer Education for All or for the majority of children. This is where the main confusion seems to lie. The expressions 'Computer Appreciation', 'Computer Science' and 'Computer Studies' have come to imply the same thing. Out of the seven syllabi mentioned, one has Computer Appreciation as its title, two have Computer Science, and four have Computer Studies. Yet there is a strong similarity in the topics they cover (BCS 1971).

Whereas it might seem from the statement of aims for the syllabi that the study of social implications will play a major role in the design of the course, in the implementation of the aims this topic was reduced to insignificance. Although six out of seven syllabi considered included social implications, either in the objectives or in the contents of the syllabi, five of them structured their contents and specimen papers in such a way that this topic could be left out altogether. One included it as a compulsory essay topic and another did not include it at all. The reason for this syndrome is simple. Computer science cannot form the basis of the study of the social implications of computers. The relationship between binary arithmetic and invasion of privacy by databanks is extremely tenuous.

Both NCC and ICL/CES published further packages. NCC called their new package "Computer Appreciation for the Majority" and ICL/CES just "Computer Studies". Their general aims, vague that they were, were not significantly different from their original publications. "Using this guide and appropriate supporting material, a teacher may construct a variety of courses to
help children to appreciate the ways in which our newest technological aid can be used to our best advantage" (Tinsley J. D. 1973).

"It is written for the ordinary fourteen and fifteen year old who is aiming not at any specialist career in computing but who is almost bound, in the course of his working life, to meet and use computers. The subject matter of this book is therefore an almost essential part of a modern child's education" (ICL/CES 1971).

There was a tacit acceptance by the publishers that the original packages did not succeed in meeting their objectives. Yet, except for a slight rearrangement of topics, and watering down, their new packages did not appear to be any different in their emphasis on computer science.

This theme is best portrayed in "Computer Education for Teachers in Secondary Schools", a report published by the International Federation of Information Processing (IFIP) in October 1972:

"it is ... important that all of society exerts an influence on the change brought about by this new technology. The most obvious channel for bringing about such a balance is within the educational system of each nation. It is thus desirable that the educators become well versed in the important concepts of computer science and that they be encouraged to develop courses making use of the ideas". (Underlining not in the original text) (IFIP 1972).

To sum up, there was a general agreement that

(a) All people should have some knowledge about computers because of their social and political implications, and

(b) This knowledge is computer science albeit at a low level.

On the face of it the two statements seem to be consistent. If this were so then this investigation might well have ended here. However, a little analysis shows that the aims (statement (a)) cannot be met by the action suggested (statement (b)). Translated in another context, the argument of IFIP cited above may be read something like this: if Mary Whitehouse
considers it important that she exert an influence on the changes brought about by broadcasting, she should become well versed in the important concepts of radio engineering.

The social and political argument for computer education would lead one to expect to be able to react confidently if for example one receives a computer produced gas bill for an outrageous amount, or when confronted with a statement about databanks. But the computer science as practiced for 'Appreciation Courses' deals with binary arithmetic, truth tables, 'nor' gates, etc. One might genuinely wonder if it is practical for everybody to start the study of databanks by doing sums in binary arithmetic. It is like trying to develop an understanding of the social nature of man from the study of human anatomy.

It seems therefore that there is a need to define the objectives to determine the structure of a possible course to meet the requirements of computer education for all.

1.2 Computer Education for all Defined

1.2.1 Preamble

It is not uncommon for educationalists to adopt the posture that the value of education is self-evident and that it has "the criterion built into (it) that something worth while should be achieved" (Peters, R. S., 1966) None the less there is "disagreement among people as to what things ought to be done in the name of education, as to what things are valuable or not valuable" (Woods, R. C. & Barrow R. St.C., 1975). General statements have been made by thinkers from time immemorial. Rousseau in Emile is quite sure that "Life is the business I would have him learn. When he leaves my hands, I admit he will not be a magistrate, or a soldier, or a priest. First and foremost, he will be a man".

Unfortunately most of the discussions in philosophy of education, which starts with general considerations from outside the educational system, stop short of concrete suggestions for curricula. They rarely develop a rational relationship between what is understood to be the aim of education, such as Rousseau's quoted above, and the educational disciplines.
Most of the traditional approach to philosophical analysis fails when
determining the structure of a new discipline which is advocated on
sociological grounds. If the aims of sex education for children are to
reduce the incidence of venereal disease and unwanted childbirths then
existing procedures cannot be easily used to develop the appropriate
curricula. The philosophical discussion plays a major role in defining
the rational mind as well as in determining the educational processes
to develop it. On the other hand traditional philosophical analysis has
a limited role to play when the aims are sociological, hence more tangible,
as it is possible, at least in principle, to determine whether a certain
educational process reduces the incidence of VD and childbirths in children.

1.2.2 Grounds on which Computer Education for All may be Defined

Computer Education is one such discipline which is advocated mostly on
sociological grounds as is indicated in the first chapter. To determine
the contents of this education one may define these grounds from the first
principle:

1.2.2.1 Bewilderment

A general confusion about any phenomenon in a society is a bad thing. It
affects the efficiency of its members in their activities and may even lower
morale. It is true that people are not walking around all day in a daze
because they are confused about computers but there is no doubt that they
are confused about them. "As the computer age gathers momentum the 'man
in the street' is very likely going to be bewildered by it all, particularly
in the next 20 years, because general education about computers and
their usage is largely unavailable today - a lack of foresight we shall
pay for. Subsequent generations will probably take computers in their
stride, and the ubiquitous machines will then be attuned to working with
people. Today, however, there are already signs of bewilderment in the

1.2.2.2 The Social Case

Many social services depend on computers to a lesser or greater degree.
To that extent people find it difficult to cope with them. A standard
answer to an enquiry regarding a gas or electricity bill seems to be that
computers do not make mistakes. Computers are affecting our lives and are going to affect them more and more in the future. People should know how to utilise computer-based services and how to react when they encounter computers directly or indirectly.

1.2.2.3 Working in the Computer Environment

It may be debatable that the aim of general education is to train children in the specific skills required by industry, but that they should be able to deal with common situations in the working environment is generally not challenged. Computers in the working environment make little or no demand on the skills of workers not directly involved with them. To realise this, people need some knowledge about computers so that they are not unduly reticent every time they hear about computers at work.

1.2.2.4 The Political Case

Databanks have political implications. Whether they are ever grossly misused in this country remains to be seen. However, in a democracy people should influence the design and implementation of systems with political implications. This influence can hardly be rational if the opinion of those involved is not informed.

If it is accepted that these are sufficient grounds to advocate a computer education for all, then the aim of this education will read something like this:

The aim of Computer Education for All is to reduce the bewilderment regarding computers in the minds of people, to help people to utilise computer-based social services, to work without reticence in the computer environment, and to develop informed opinion about computer systems with political implications.
1.2.3 Computer Education for All defined as Computer Awareness (CA)

The appropriate education to meet this aim may be called Computer Awareness (CA). Computer Awareness is taken to be the possession of sufficient knowledge to enable inferences, general and social, to be made on the basis of what is seen or heard about computers.

If computer systems are understood to be at par with other technological systems in a society, such as transport systems, communication systems, broadcasting systems, etc., then the possession of computer awareness will enable the same quality of reaction as does the possession of awareness in the society of these other systems. There is a general awareness in the society which meets people's needs reasonably well. This awareness enables them to utilise social services, apply for jobs in a variety of environments, exercise their political rights, and do so without undue bewilderment.

1.2.4 Why Computer Awareness may not exist at present

In time perhaps the society will acquire awareness of computer systems as it did with the other innovations. But there are three main differences between the computer and other systems which may be the cause of the present lack of computer awareness in the populace as at present:

1.2.4.1

Other innovations in the past have had some kind of sensory image related to their function in the society. The motor car is seen to travel, cause traffic jams, etc. Radio broadcasts are heard far away from broadcasting houses, and heat radiated by electric fires is felt. This direct perception of systems helps to develop awareness. But those aspects of technology which are not directly perceived are harder to grasp. When a telephone operator says that there is heavy traffic on international lines, hence delays and chaos, one generally accepts this with greater difficulty than a smashed up public telephone.

Computers are never sensed in the way a motor car is. The sensory image around which awareness is generally developed is, therefore, missing.
The awareness of the other systems grew at a rate commensurate with the rate of development of these systems. One might say that the rate of usage of some technological systems such as the motor car was determined by the rate at which the members of society developed their awareness. It was not possible to have more motor vehicles at any given time than there were drivers to operate them. It is true that computer systems cannot develop faster than the expertise required to 'drive' them, but the impact computers make on the life of the society is greater by many factors than that of the motor car with the same man power. Also, initially, the significant effect of the motor car was only felt by those directly concerned - the drivers and the passengers. By the time it started affecting the 'disinterested bystander', as it does, for example, by polluting the environment, the society's awareness has either caught up with it or else it will bear the consequences.

The rate of application of computer systems has risen much faster than both the rate at which society develops a process of information diffusion, and the rate at which individuals can convert this information into awareness. That this rate of adaptation to innovational changes is low can be demonstrated by another albeit trivial example. This country has completed the changeover to decimal currency. This change is a minor one compared to what computers do to information processing, yet there have been signs of upset in people's ability to cope with this change. However, in time and without major social and political consequences people will adjust to this change.

Some of the confusion about computers has been a result of the actions of computermen themselves. Newell and Simon predicted in 1964:

"(i) That within ten years a digital computer will be the world's chess champion, unless the rules bar it from competition.

(ii) That within ten years a digital computer will discover and prove an important new mathematical theorem.
(iii) That within ten years most theories in psychology will take the form of computer programs, or of qualitative statements about the characteristics of computer programs." (Dreyfus H. L., 1972).

Statements such as these have added to the mystique about computers. If the computers are 'ultra intelligent' and the computer processed bank statements do not include information like the names of the payee, bewilderment results. Although the way mass media handle information about computers may also be contributing to the general bewilderment, the primary sources of this information are computermen themselves. In a sense the confusion in the mass media about computers reflects the attitude of the society rather than is a cause of it. A great majority of people including the gentlemen of the press are still lay in computer matters.

One might explain this phenomenon by a simple proposition: as far as their knowledge about what lay people can and will cope with is concerned, computermen are in an ignorance-trap: they do not know that they are ignorant. (Makkar L., 1975).

In fact some of them have already decided that a significant proportion or even the majority of people, are incapable of learning anything about computers. Martin and Norman in "The Computerised Society" suggest that "... the bottom 30%, and perhaps as many as 70%, will be among those for whom many sources of employment will have dried up ... they will generally be in a lower IQ bracket also ..." They go on to say that "a ... solution may emerge allowing the less capable fraction of society not to work at all and to be supported by those who do". (Martin J. & Norman A. D., 1970).

1.3 The Nature of General Awareness

1.3.1

An investigation of the nature of general awareness may be the first step toward determining how and what to teach for the purposes of computer awareness.
1.3.1.1 The System of a Society

For the purposes of awareness a society may be thought of as a dynamic super-system made up of inter-related sub-systems. The way in which each constituent technology based system develops is a function of two elements:

(a) the inherent properties of the technology, and

(b) the nature of the rest of the society (Figure 1).

For example, consider the systems based on aeroplanes. The civil aviation systems include airports, booking offices, travel agents, road transports, etc. The design of such systems is dependent on other transport systems available, on fuel costs, the size of the country, politics and various other factors. This explains why the civil aviation systems of the United States are different than that of European countries, which in turn are different in some of the under-developed countries in spite of the fact that the nature of the aviation technology is the same.
General awareness which has developed naturally in a society is almost exclusively concerned with the nature of such systems and the relationships between them (see Figure 2).
1.3.2.1 Properties of Systems as directly perceived

To determine the nature of general awareness one may consider the knowledge base of a person who is able to make inferences on the basis of what he sees or hears in society. An aware person knows that motor cars can travel faster than humans, but that humans are more flexible - they can sidestep while a car cannot. Regarding television he knows that it runs on electricity. He knows that there need be no direct connection between his television set and the broadcasting station. He knows that aeroplanes fly and that they have propeller or jet engines. The first ingredient of the knowledge for general awareness therefore are the properties of constituent technology as directly perceived.

1.3.2.2 Properties based on the utilisation of the System by a Society

A generally aware person also knows some properties of constituent systems as they emerge due to the utilisation of these systems by the society. He knows that an aircrash is almost always a total disaster. He knows that airports are generally built out of town because they need long runways for takeoff and landing. He knows that the quality of production of television programmes has nothing to do with radio engineering. He knows that he needs to pass a driving test before he is allowed to drive a car. The second ingredient of the knowledge for general awareness are the properties of the constituent technology as employed in practice.

1.3.2.3 Relationship between Systems

A generally aware person knows the relationships between the systems as they exist at any given time. Consider the business executive in Birmingham who wishes to make contact with an important customer in Belfast. He knows that he can travel to Belfast by train and ferry, by car and ferry, by air, etc. He has knowledge of the properties of these systems as described in 1.3.2.1. He also knows the costs of travelling by various modes and the time required to travel. He considers other methods of making contact - telephone, telegram and letter. He has the knowledge of the properties of these various systems and sub-systems and
the relationships between them. The quality of his decision is partly
determined by this knowledge. The third ingredient of the knowledge
for general awareness is the relationship between the properties of
various systems.

1.3.3 Other Elements of General Awareness

1.3.3.1

The most common elements of the knowledge possessed by people who are
generally aware do not include detailed and technical knowledge of the
technology and skills such as is possessed by professionals. People
who appreciate that aeroplanes are noisy do not necessarily know the
physics of sound. Even for more common products of technology such as
a motor car, or even a bicycle, the actual knowledge of the technology
is confined to the 'rules of thumb' rather than any systematic under­
standing.

1.3.3.2

General awareness is acquired in the first place by direct experience of
the systems of the society, such as watching a colour television for the
first time and subsequently. Secondly it is acquired through indirect
experience via, for example, a film depicting an aircrash. Thirdly it is
acquired through information diffusion such as newspaper stories, social
chat and radio programmes.

1.3.3.3

General awareness assumes the ability to 'transfer' principles acquired
in one situation to another. If somebody knows that aeroplanes drop
bombs on enemy troops or drop food on flood stricken areas, they are able
to accept that aeroplanes spray insecticide on crops when they hear about
it for the first time.

1.3.3.4

The quality of a decision made by individuals is dependent on other
factors in addition to possession of general awareness. The final
decision made by the business executive in Birmingham will also depend on his personality, his political opinion, his personal ambition, his nervous energy and so forth. However, everything else being equal, general awareness should improve an individual's performance in the personal, social and political areas mentioned before.

1.4 The Nature of Computer Awareness

1.4.1

The nature of Computer Awareness (CA) may be deduced from the nature of general awareness bearing in mind the following qualifications:

1 Since it is intended that CA is taught whereas general awareness is developed outside formal learning, CA is defined more exactly than general awareness is as at present.

2 The properties of an existing technology mentioned in 1.3.2 are more apparent i.e. are more disposed to direct perception than equivalent properties of computer systems.

3 Teaching of CA does not start with a 'clean slate' mind of learners as they already have some concept of computers often grossly wrong. CA therefore has to dispel some of the myths in addition to construct a useful base of knowledge.

1.4.2 The Structure of Knowledge for CA

The contents of knowledge for CA should ideally include

(a) the primary properties of computers as machines,

(b) the properties of computer systems as they are used in this society,

(c) the properties of these systems in the social context e.g. their relationships with other systems of the society, and

(d) an ability to transfer this knowledge to novel situations.
1.4.2.1 The Primary Properties of Computers

There are two main properties of computers which form the basis of all their usage.

1. Computers are fast processors of numeric and non-numeric information.

2. Computers allow fast storage and retrieval of large quantities of information.

These properties are at par with "aeroplanes can fly fast" and "mechanical diggers can move large quantities of earth". However, these bland statements are of little use if they are not realised through experience. In practice they are rarely experienced in isolation. Even if the first contact somebody has made with an aeroplane is when he sees it flying past, it is doubtful that he will become aware of aeroplanes with that one experience. It is always in context that an experience leads to awareness. This experience is an application of the device. The experience of an application inevitably includes other properties such as "mechanical diggers are operated by human beings" or "the aeroplanes are noisy".

1.4.2.2 Additional Properties of Computer Systems

These properties emerge as the computers are organised as systems and are put to use by the society. These properties are often specific to the situations experienced and arise naturally out of them. There is a large number of such properties. Some examples of these properties are:

1. Computers can carry out calculations fast.

2. Computers can reproduce text.

3. Computers can scan a file quickly to update only a few items.

4. Computers follow instructions in the form of a computer program.

5. Computers can stay in a state of readiness, at all times, to deal with an emergency.
6 It is possible to have incorrect information on computer file.

7 Computers can print out information in a given form.

8 Computers can check certain types of input errors.

9 Computers cannot check all types of errors.

10 Computers cannot generate factual information.

Whereas these properties of computer systems form the main body of the knowledge for CA they form the basis of the primary properties as defined in 1.4.1.1 on one hand, and are extended to the properties as defined in 1.4.1.3 on the other.

1.4.2.3 Properties Dependent on the Nature of a Society

Some properties of computer systems exist only because of the nature of the rest of the society. As the economy of a country develops computer systems become useful because of the high cost of human labour. Similarly computer systems are used for boring and routine jobs when more interesting jobs are available. Some such properties are:

1 Computer Systems make economic sense only if they make possible large savings in labour.

2 A large computer system is useful, as a rule, only if it is used over and over again.

3 Computers are better than humans in doing routine and boring jobs.

Some of these properties arise naturally from situations experienced and some are realised through personal thought processes as CA develops.

1.4.2.4 Transferability

The understanding of the properties as described above includes the ability to transfer knowledge and skills to novel situations.
Three categories of questions may be asked about computers:

(a) What is a computer?
(b) How does a computer work?
(c) What does it do?

(a) is concerned with what is known as computer hardware and is studied as Computer Electronics, Computer Technology, etc.

(b) is concerned with computer software with an associated discipline of Computer Science

(c) is concerned with computer applications and may be studied as e.g. Computerised Information Processing Systems.

CA concerns itself almost exclusively with the last category. Some aspects of (a) and (b) inevitably come into CA as the background information but not as disciplines in their own right. Thus a computer aware person may know that computers follow instructions in the form of computer programs but may not be able to write a computer program himself, or he may know that a computer terminal is sometimes connected to the main frame computer from a distance, but may not know the technical details of this connection such as the switching mechanism at either end.

Computer hardware and software are much better defined than category (c) above. Computer hardware is magnetic discs, line printers, central processors, etc. Computer software is compilers, programs, codes. This might further explain why teachers deciding for the first time what to teach children chose (a) and (b) rather than (c). It is not contended that (a) and (b) are easy disciplines to follow, only that they are more easily defined. It is so much easier to describe aeroplanes as having wings for lift, propellers or jets for thrust than to describe them as change agents of the society.
1.4.4 Computer Awareness and Academic v Practical Subjects

One view of the academic subject is that it is theoretical, broad and not directly related to life. The practical subjects are understood to mean narrow, concrete, and often manual. In this sense accounts and woodwork both are practical subjects. Economics is an academic subject, so is History of Art.

Another way of looking at the same division is the opposition of experience and true knowledge. "... experiences always involved lack, need, desire; it was never self-sufficing. Rational knowing, on the other hand, was complete and comprehensive within itself. Hence the practical life was in a condition of perpetual flux, while intellectual knowledge concerned eternal truth" (Dewey John, 1916).

Many changes in thinking have taken place since the Greeks due to the changes in social patterns and particularly due to the development of experimental science. But the antithesis between the two categories is still largely in existence. In any case, the attempts in bringing the two categories together have been in increasing the practical content of traditionally academic subjects and vice versa leaving the original definitions of the subjects more or less in tact. Learning by doing is encouraged on the grounds of efficiency and is not due to any basic shift in thinking about what needs to be taught. 'Practicals' in a physics course contribute to the appreciation of the scientific method as a mental discipline. The engineer is still trained to deal with practical aspects of science. Any academic content of his course is aimed at "giving the wider context to his work" rather than to developing a rational mind.

CA does not neatly fit into either category. It is not practical in the sense that it trains people to become computer operators, technicians or programmers. On the other hand it is related to life, unlike many academic disciplines. But it develops general principles like academic disciplines. CA seems to be a third category of education: it deals with general principles which are directly related to life.
The other subjects which form what may be called 'civic education' are understanding of government, law, sex education etc. These subjects are not in great favour with educationalists. Take sex education for example. It is not practical as it is aimed at making children aware of the emotional and physical dangers of casual sexual relationships. It is not theoretical as it is aimed at getting children to apply the lessons learnt in practical problems. Its contents do not include either the theoretical study of human anatomy or practical handling of birth control devices. It is about general principle children may apply in real practical situations.

This may be another reason why CA may have eluded the teacher in the classroom. 'Practical' teachers chose electronics and computer building for their children. 'Academic' teachers chose binary arithmetic and truth tables to enlighten the children about computers. Quite mistakenly these teachers also chose computer programming as a topic. To justify this on academic grounds they advocate that it develops logical thinking (IFIP, 1972).

1.4.5 Computer Awareness and Value Complex

An aware person displays signs of having a value complex which is not basically ethical in nature. He makes statements like "cars are a nuisance on the roads, their production should be controlled" or "democracy is the best political system". These statements are not purely ethical in the sense that a statement like "human life is supreme" is. They are a function both of a person's ethical code and his awareness complex. Imparting of value complex is not in the aims of CA. However, it is contended that once an individual has successfully acquired CA, he will then be able to answer the question "what is your attitude to the establishment of a personal data bank?"

But his answer will be determined by his attitude to privacy of the individual as well as by his other interests. His answer might be that he does not care because he is not particularly bothered with either privacy or with business expediency promised by the advocates of data banks. Or he may be directly involved with running an enquiry service for processing loan applications and can see advantage to himself for computerising the information system. Another person may value privacy more than business expediency and hence approach the question with caution. Both attitudes, however, will be informed if they are based on CA.
In the discussion in Section 1.1 regarding some of the existing educational material on computer education it was pointed out that there was a difficulty in relating computer science topics with the social implications of the computers on logical grounds. In the light of the discussion above it may be seen that social implications of computers cannot be a part of any education, that each individual will work it out for himself if he is sufficiently aware of computers.

Cognitive values, however, must be a part of CA. Scriven "makes a distinction between values acquired in conjunction with learning, such as the value of objectivity and the scientific method, and moral values such as empathy, and sympathy, which cannot be taught with cognitive techniques" (Scriven J. R., 1961). The possession of cognitive values such as the value of double checking the input to the computer, or that of not accepting the computer output as gospel truth, are therefore part of CA. Not included are absolute values such as "computers are good" or "computers are bad".

1.4.6 Defining Educational Objectives for Computer Awareness

Detailed statements about objectives for a course on CA have to wait until a suitable method for teaching is discussed later. It may be useful, however, to note the implications of the structure of knowledge for CA to the definition of objectives for education material.

Four ingredients of knowledge for CA were discussed in 1.4.2. Of these the primary properties of computers per se (1.4.2.1) are based on the experience of the properties of computer systems (1.4.2.1) and are not internalised by the learners as such. They serve as a definition of computers for CA purposes. They are abstractions which remain in the background when an aware person draws inference on the basis of what he sees or hears about computers. The contents of any educational material for CA therefore do not include teaching of these properties.

The major part of educational material for CA is the properties of computer systems as described in 1.4.1.2. These properties are more specific than those mentioned in 1.4.1.1. They form the skeleton around which a course for CA is built.
An experience leading to any awareness is rich and includes many aspects which are difficult to define logically. Does licking a postage stamp before sticking it on a letter contribute to awareness of communication systems? Will awareness of nutrition be different if there are no fish and chip shops around? At this stage it seems that the internalisation of the properties mentioned should be through experience of real, or at least realistic, situations involving computer systems. Teaching methods adopted for this purpose will have a bearing on the question of how much detail of the situations dealt with in the educational material developed.

Relationships of computer systems with other systems arise naturally through experience of situations mainly involving computers. In a way these relationships are an essential part of the repertoire of an aware person. But the development of this part of the awareness depends heavily on the existing awareness complex of the learner. This is taken into account when determining the structure of the educational material for the purposes of CA. Further, due to the previous experience of the learners in relating the properties of one system with another as awareness is developed, the requirement of teaching this aspect of CA is less than that of the teaching of properties of computer systems, though it cannot be ignored altogether.

Finally the objectives for CA include the development of the skill to transfer knowledge learnt in one situation to a novel one. How this can be done will be discussed in the description of the method of imparting CA. Suffice it to say that since an aware person obviously demonstrates this skill a method he would adopt to acquire it must exist.

To sum up, a computer aware person possesses the knowledge of the properties of computer systems acquired through experience of realistic situations, is able to develop an understanding of the relationship of these properties with relevant properties of other systems and is able to transfer his knowledge to novel situations.
Bloom, Krathwohl and Masia (1971) place awareness at the bottom rung of the affective domain. Receiving, Responding, Valuing, Organisation and Characterisation are given as the five categories of the affective domain, in that order. Receiving (attending) is further sub-divided as 'Awareness', 'Willingness to receive' and 'Controlled or selected attention'. They state that 'Awareness is almost a cognitive behaviour. But unlike Knowledge, the lowest level of the cognitive domain, we are not so much concerned with a memory of, or ability to recall, an item or fact as we are that, given appropriate opportunity, the learner will merely be conscious of something - that he takes into account a situation, phenomenon, object or state of affairs ... The individual may not be able to verbalise the aspects of the stimulus which cause the awareness.

It is important to note that a range of awarenesses can occur along a continuum from very unsophisticated or gross awareness to highly sophisticated and detailed awareness."

CA as defined does fit the above description but only at a superficial level. It is true that CA does not concern itself with memory or ability to recall an item or fact, and also given appropriate opportunity an individual takes into account a situation, phenomenon, object or state of affairs. But CA as defined implies more than the statement, "the learner will merely be conscious of something" does. It also implies that an individual will be able to draw inferences from "a situation, phenomenon, object or state of affairs". In this, CA is at par with an objective such as: "The ability to distinguish among warranted, unwarranted, or contradicted conclusions drawn from a body of data" (Bloom S. B., et al, 1969) given as an example for sub-division of 'Interpretation' for the category of 'Comprehension' in the 'Cognitive Domain'.

Another main difference between CA defined here and awareness defined by the authors cited emerges from the examples given them to test awareness. Their example 1.1 (C) and (D) suggests a test for 'Awareness of the existence of the chief statesmen in international affairs'. The test is given below.
Directions: On each line below fill in the blank space.

<table>
<thead>
<tr>
<th>Statesmen</th>
<th>Nation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Charles De Gaulle</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Federal Republic of Germany (W. Germany)</td>
</tr>
<tr>
<td>3</td>
<td>Nationalist China (Formosa)</td>
</tr>
<tr>
<td>4</td>
<td>Cuba</td>
</tr>
<tr>
<td>5 Mao-tse-Tung</td>
<td></td>
</tr>
<tr>
<td>6 Gamal Abdul Nasser</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Israel</td>
</tr>
</tbody>
</table>

A Task for Awareness from Bloom, Krathwohl and Masia

This test and most others given in fact test knowledge at its most elementary level i.e. Knowledge of Specifics (Book 1 page 65) according to the authors own classification. In fact, 'Knowledge of Specific Facts' is defined as 'Knowledge of data, events, places, etc.'. It is difficult to accept that the authors mean to equate 'awareness' with 'knowledge'. If they do, then CA is categorically distinguishable from their definition of 'awareness'.

However, other examples given do not equate 'awareness' with 'knowledge'. Example 1.1 (E) states its objective as "Consciousness of colour, form, arrangement and design in paintings". From the 40 stimulus pictures the student is instructed to select pairs of pictures "which have important artistic features in common" such as colours, design, mood, and so forth. He is warned against making major use of similarity of subject matter in his pairing. CA as defined does seem to agree with the spirit of the test.
## A METHOD OF LEARNING

### 2.1 INTRODUCTION

### 2.2 AN ANALYSIS

### 2.3 FORMAL DEFINITION OF THE METHOD

#### 2.3.1 The Postulates

#### 2.3.2 The Cognitive Map of Reality

#### 2.3.3 Human Perception

#### 2.3.4 Imperfect Relationship between Cognitive Map and Reality

#### 2.3.5 Learning

### 2.4 GENERAL
2.1 Introduction

In an attempt to 'discover' a learning method suitable for CA, an investigation is made into the conditions in which people acquire awareness outside institutional learning. These conditions are analysed in section 2.2. The method is formally defined in section 2.3 as a set of postulates which are explained in detail. They are then related to some research work which is relevant to the method. The actual concept of 'learning' is discussed in section 2.3.5 on page 48.

This method was actually used in the development of a course on CA. How this method of learning is transferred into a method of teaching is discussed in Chapter 4.

2.2 An Analysis

An attempt was made in Chapter 3 to define General Awareness. A corollary to that thesis is that since people do actually require awareness there exists a method of learning which they employ. It seems therefore that, instead of developing a method either from classroom experience, or from research, both of which deal mainly with the established disciplines, an attempt should be made to start with, to 'discover' how and what people learn when left to their own devices. Once defined, however, the method is open to critical appraisal like any method in education. It will also be of interest to see how this method ties up, if at all, with experimental work done in the field of learning.

The author gave a lecture on "How and What we Learn" to the Department of Education, Cambridge University on 23 June 1976. The following extract is reproduced here to establish the approach adopted to 'discover' this method:

"Have you ever wondered how seemingly ordinary people acquire a massive awareness of their surroundings outside formal schooling? Consider this common situation.
A housewife sits down with a cup of coffee at mid-morning and deliberates whether to start spring cleaning in the afternoon or wait for the delivery of the new vacuum cleaner promised for two days ago. But there are certain jobs in spring cleaning which do not need a cleaner—such jobs as wiping the vinyl wall coverings with a wet cloth, dusting all the electric lamps and shades, giving a coat of teak oil to the pine Welsh dresser. She picks up the telephone and dials the local Electricity Board to find out why the hoover has not been delivered. She is told that the delivery man could not find her house from the address she gave them. She gives the instructions as to how to find the house starting from the block of flats which the delivery man cannot miss. It is due to this new block of flats, she tells herself, that the whole problem started. The Post Office have renumbered the houses and nobody except the postman can now find any address. She must organise a representation to the Post Office to put the numbers the way they used to be. But for the present she makes a decision to washup the crockery displayed on the Welsh dresser in the afternoon and goes to the kitchen to start cooking lunch for her children who will be home soon after twelve.

It is obvious that the knowledge base on which she makes her seemingly trivial decisions is large and complex. What is this knowledge base? Regarding the hoover, is it about electricity and magnetism, or is it the vacuum physics, electrical engineering or perhaps just the maintenance of electrical equipment, or maybe a little bit of all these? What is the answer to the same question regarding wall-papers, carpet shampoos, disinfectants, furniture, telephones, Electricity Boards, the Post Office, street numbering of houses? Is the structure of this knowledge 'logical' as commonly understood?

How did she acquire this knowledge? Did she employ, perhaps sub-consciously, behaviourists instrumental conditioning or maybe Pavlov's classical conditioning? Did she get a reward by some natural mechanism every time she made a 'correct' response and a punishment for an 'incorrect' response? What was the motivation for her to learn all that long before she used it in the situation described above? How did she develop the confidence that she can cope with complex situations requiring a wide knowledge base?
Better still ask the question what is the nature of curiosity, what satisfies this curiosity and what mechanisms exist in all of us to enable us to satisfy our curiosity. Indeed how does curiosity arise in the first place?

Obviously, I have never wondered about the phenomenon which I do not know even existed. If I hear a statement about something that I cannot relate to I ignore it. It must be so, otherwise we will all be spending long hours in trying to understand every event that takes place without getting anywhere.

Further, even if we wonder about some things we may not do anything about it unless we believe that there is a reasonable chance of finding out more about them. Before I saw the photographs of the other side of the moon taken by the astronauts I did not do anything about satisfying my curiosity about what the other side of the moon looks like.

The two essential ingredients of the situations in which human beings get curious and do something about satisfying this curiosity are

(i) they have at least partial knowledge of the event they are observing or they believe that they have, and

(ii) they believe that they have a reasonable chance of finding out more about it.

However after the first tentative attempts they might give up if they feel that they are not getting anywhere.

Consider further what it is that you are trying to achieve when you want to improve your own performance in a given situation. Take cutting a hedge, making up a garment, drawing a picture, or anything that catches your fancy. Have you never spent time in improving what you have produced just that little bit more - even if nobody else will notice it? If you know that there is a flaw in your own performance you have motivation to remove that flaw. There need be no external pressure on you to get the hedge just so, or to get all the curves in the picture you are drawing perfectly matched.
I believe that if only we could harness this source of energy and enthusiasm which apparently all of us have we may increase efficacy of our efforts significantly."

Acquisition of general awareness as an on-going activity assumes the existence of a cognitive map of reality in human beings. How this map is built in the first place from the time of birth, or even before the birth, is not a question easily answered. However most of the learning is concerned with the development or modification of the cognitive map rather than with 'mapping on a blank sheet or paper'. This discussion therefore ignores the question as to 'how it all starts'.

The cognitive map is made up of units which in the past proved to be useful in dealing with reality in the perception of the individual. These units may be facts and figures or they may be procedures for achieving certain ends. They may be well defined such as "the tyre pressures of my car are 22lbs/sq in front, 24lbs/sq in rear", or they may be just 'rule of thumb' such as "I can tell when my car is going to stall because of the noise the engine makes". The common feature of all the units in a cognitive map is that they have a function to perform - that of enabling an individual to deal with reality.

The units of the cognitive map may or may not have a direct correspondence with 'objective' truth, if there was such a thing, even if solipsists' plea was ignored. Provided that 'the noise in the engine' performs its function, it will continue to be the part of the cognitive map. The 'truth' might be that if a certain nut was tightened on say the aircleaner, the noise will stop. Now the engine might stall without this clue. Scientific Method only helps to discover what is useful, rather than helps to discover the absolute truth. Perception of colour green or perception of a numerical reading representing the wave length of this colour on a measuring device will both be assimilated in the cognitive map in so far as they are useful in dealing with the reality.

What is useful is determined by the existing cognitive map. Clearly if a sensory input, such as a sentence spoken in a language foreign to the individual, which cannot be related to the units of the existing cognitive map is going to be ignored. On the other hand a sensory input which is only a duplicate of inputs received many times before will only
establish an existing unit a bit more firmly. New units are acquired when they are related to the old units and are found to be useful in dealing with the reality. One might say that learning has taken place.

Sensory input and the perception of it are two distinguishable events. One may see a dark patch on a carpet and perceive it as a wet patch. This may be because in the cognitive map there exists a relationship between dark patches and wet patches on carpets. If however a patch lighter than the surrounding colour is seen, for the first time on a carpet an individual may be inclined to investigate the phenomenon further. If he does and finds a new relationship which successfully explains the phenomenon in his perception, he will add this new unit to his cognitive map. The condition necessary to motivate an individual to explore further, it seems, is that the phenomenon perceived relates to the existing cognitive map, but only partially. Motivation in the sense used is in fact not biological motivation such as that generated if one were hungry. Further it is more of a selection than motivation. In the example a person may select to investigate the light patch on the carpet rather than to read the evening paper. If it is understood that motivation implies an urge to direct one's efforts rather than an urge to act per se, then it is a useful concept in dealing with learning situations. (This concept is not dissimilar to the common usage of the word. Consider a young man playing football at an odd hour e.g. 9.00 pm. One might say he was not motivated if he was preparing for an 'A' level in Physics. On the other hand one might say he is highly motivated if he was preparing to become a footballer.)

The strength of cognitive motivation thus generated is finite.

If an individual does not succeed in satisfying his curiosity before his motivation is exhausted, he will give up trying. In fact he will not even start trying if he believes he will not succeed with the effort/time he might have. Thus if after a cursory look at the light patch on the carpet an individual decides that to 'get to the bottom of it' he has to remove all the furniture away from the carpet to look underneath, he may just be content with not satisfying his curiosity at that time or at all.

If this analysis is valid then the points to remember are that
(a) Perception plays a major role in a learning process.

(b) The existing cognitive map, as well as the perception of the environment at any given time, determine the direction and strength of the effort that will take place.

(c) Success before motivation is exhausted is essential for learning to take place.

2.3 Formal Definition of the Method

A formal definition of the method discussed in the last section is given as a set of postulates.

2.3.1 The Postulates

(a) Human beings possess a cognitive map of reality in the form of functional units.

(b) Human perception of events has the following properties:

(i) it is dynamic

(ii) it is dependent on the event as well as on the existing cognitive map

(iii) it comes in functional units.

(c) If the cognitive map relates, but only imperfectly, to the perception of an event then a motivation exists to render the relationship perfect.

(d) Learning takes place if

(i) the imperfection cannot be removed without co-opting a new functional unit into the existing cognitive map.

(ii) the total effort required to learn and to remove the imperfection is commensurate with the motivation generated.
There is a certain amount of experimental evidence available on which these postulates may be justified. But the strength of these postulates depends mainly on the coherent nature of the four statements taken together. To this extent the finer shades of meaning of each postulate are dependent upon the nature of the whole system. To clarify this aspect of the method an example of how one may learn is first given before a discussion of each postulate is undertaken.

Consider a gardener who planted a number of dahlias in a bed in his garden some weeks ago. He dug the bed to one spade depth, mixed some rotted garden compost and laid the tubers three inches below the surface. He watered the bed if it did not rain for three days. He then waited patiently for the plants to grow and flower. Digging the bed to one spade depth, mixing some rotted garden compost, etc., are all functional units in his cognitive map: these are the units, howsoever acquired in the first place, which worked in the past. If he firms the soil around each tuber without being aware of it, this is also a functional unit in his map. When the plants start flowering and everything is as expected he will not learn anything except perhaps in a marginal sense, and except that his old functional units will be established more firmly. What happens if he sees one plant which is flowering more vigorously than others? If he cannot explain away this event by an old functional unit such as 'there was one tuber which seemed to be a different species of dahlia', the relationship between the perception of the event and the existing cognitive map will be far from being perfect. He will direct his efforts, for a while, to remove this imperfection which may require acquisition of a new functional unit. He may ask a neighbour or somebody who might know to explain the phenomenon. Or he may consult some literature on gardening. However, the functional unit he will accept has to be at the same functional level as the units in his existing cognitive map. If some botanical expert tells him that osmosis taking place between the two organic compounds through the membranes was more active in one plant than the rest of them, he will either convert this information to the hierarchal level of his existing units himself or continue to ask questions. If he is told that because this one plant received twice as much water as other plants (with precisely the same result as explained by the botanical expert) because it is at the corner of the border and had the benefit of the water
every time the lawn was watered, he may just accept this as a new functional unit. All this assumes of course that the gardener will only continue to investigate this phenomenon as long as his motivation (which is finite) lasts. The new functional unit will be tentative to start with. He may try to prove it by either giving more water to the rest of the plants, or by placing the sprinkler while watering the lawn so that this one plant does not get extra water. If the new hypothesis is not confirmed either by deliberate trials or by experience it may be lost.

2.3.2 The Cognitive Map of Reality

That human beings possess a cognitive map (Tolman, 1926) may be accepted as self-evident. The nature of this cognitive map, however, needs elaboration and justification. Clearly the discussion must pivot around the expression 'functional units'. To start with one may say that the elements of a cognitive map are defined according to the role they play in relating to reality. Thus one remembers the sentiment of a sentence rather than the exact words that aroused the sentiment. These elements are found in groups within the cognitive map. The elements in a group have common functional category. The concepts of hate, love, anger group together. And the concepts of run, jump, climb, form another group. The categories are not 'logical' as commonly understood. Thus 'logically' one may lump together a food mixer and a vacuum cleaner (as being electrical devices) for the convenience of the Department of Trade and Industry or even for retailing. But dependent only on the use a housewife makes the concept of 'food mixer' and the concept of 'beating eggs with a fork' must stay together.

The functional units are hierarchal according to the levels of use that is made of them.

A house is made of bricks and mortar.
Bricks are made of clay and sand
"Clay consists of alumino silicate minerates in particles of infinitesimal finess" (Woodforde J. 1975)
can all exist as functional units within a cognitive map but at different levels.
Both functional categories and hierarchical levels of units have an important role to play in dealing with the reality. Take an example of a motorist who is driving from place A to place B. Depending on his past experience (i.e. his existing cognitive map) he may refer to road signs, road maps issued by Shell or the AA or just travel from one identifiable spot enroute to another until he gets to B. In this context the category of the units, which are invoked, depend on the similarity of usage made previously or expected to be made in the immediate future, i.e. to deal with the reality of the road network to get to B. Similarly the functional level of the unit invoked will be determined by the reality of the situation under consideration. He will look up a map if, in his perception, road signs are not leading him anywhere. He will not start reading his compass, assuming the relevant functional units are within his repertoire, unless higher level units have not been successful. All these units are in the same functional category but at different functional levels.

All mathematical formulae which exist in a cognitive map are at a higher functional level than the procedures to derive them. Given a situation highest level units are first invoked and if necessary, either because higher level units do not deliver the goods or because further clarification is required, lower level units are then invoked. If, however, the existing repertoire of the functional units is exhausted before the relationship with the event perceived is completed then a potential learning situation exists and is discussed later on in this chapter.

To sum up, cognitive map of an individual does not consist of a 'photographic image' of reality with one to one correspondence. It consists of functional units derived from the use made of concepts in dealing with reality. These units have functional categories and functional levels dependent upon the categories and levels of use made of the concepts in the past.

The concept of the cognitive map is further clarified during the discussion of the rest of the postulates.
Human Perception

To understand how a new functional unit is co-opted into the cognitive map one must understand the difference between 'what a person saw' and 'what was shown to him'. Perception of an event rather than the event itself matters on two counts. First the interaction that takes place is between the cognitive map and the perception of an event, and secondly if a new unit is added to the existing cognitive map it will be defined by the perception of what took place rather than what actually took place. The nature of perception therefore plays a major role in developing a concept of 'cognitive learning'.


2.3.3.1 Two Properties of Perceptions found in all Dynamically Organised Systems

(i) In all dynamically organised systems, the properties of parts are determined partly by the larger wholes within which they exist.

(ii) In all dynamically organised systems, the distribution moves towards a 'best form' or 'simplest possible organisation'.

2.3.3.2 Six Distinctive Properties of Perceptions as Dynamically Organised Processes

(i) Many perceptual situations are capable of arousing and supporting not simply one perceptual organisation, but any of two or more rather drastically different perceptual processes.

(ii) In such vieldeutig situations, whichever perceptual organisation occurs first will tend to obstruct the occurrence of alternative perceptual organisation which otherwise might have been just as likely or even more likely to occur.
A sustained use of any perceptual process tends to prevent the continuance of that perception and tends to permit or facilitate some other perception instead, from the same stimulus materials.

The occurrence of a perceptual process, even briefly in some cases, tends to leave enduring changes that will help produce the same sort of perceptual organisation even after some intervals of time and even with somewhat different stimulus material.

Learning to perceive such vieldeutig stimulus materials in a second way does not necessarily destroy or even diminish the capacity to perceive them in the original manner, but leaves the individual with two alternative mechanisms.

Both in cases in which the alternative perceptual organisation are incompatible with one another and in cases in which different properties of the stimulus materials could easily be perceived simultaneously, perceptual processes are basically selective or abstractive.

Since the objective of this dissertation is to discover a method which works, theoretical discussion for its own sake is kept to a minimum. It is however of some importance that when a situation is presented to a potential learner the designer of the course is aware of what the learner is likely to perceive. To this end it may be noted from Leeper's list of the properties of perceptions that perceiving and learning are intimately related - that the current perception not only depends on previous learning (i.e. on the existing cognitive map) but also on what is perceived first if the perceptual situation could support alternative organisations. Further sustained use of a perceptual process tends to prevent the continuance of that perception and tends to permit some other perception (properties (i), (ii) and (iii)). At a practical level just because the designer of a course perceives a situation in one way does not necessarily mean that the learner will also perceive the situation the same way. However, given time the learner will perceive the situation differently without any aid from the experimenter. Properties (iv) and (v) in fact refer to the effort of learning on perception and will be discussed later. Property (vi), however, is of some relevance.
Perceptions are basically selective or abstractive in certain conditions. These conditions exist when the situation perceived is overloaded with information. The perception of the situation will ignore some of the information and utilise only part of it. How many times teachers have presented a class with situations bursting at the seams with information in an effort to make their lesson rich, and later found that the class missed the point!

There are some other properties of perceptions which any designer of a course material will do well to be aware of. R. L. Gregory's thesis that perceptions have hypothesis like properties is of some use here (Gregory R. L., 1974). Only those properties which are of use for designing a course are given:

(i) Perception allows behaviour to be generally appropriate to non-sensed object characteristics.

(ii) Perception is surprisingly good at 'extracting' familiar objects from background clutter.

(iii) Perception of highly unlikely objects tend to be mistaken for likely objects, unless there is a rich abundancy of sensory information.

In Gregory's words

"We see but two or three legs of a table and act as though it has four legs. We sense a brown patch but act as though it is wood - hard, easily scratched and strong enough to support a thesis."

One might challenge Gregory on that does one actually perceive four legs when one sees only three? Is it not more accurate to say that one perceives a table when one sees three legs supporting a platform? If so then perception comes in functional units as already in existence in the repertoire of an individual. One can in fact deduce the properties (ii) and (iii) from this simple proposition. Another way of saying that perceptions are good at extracting familiar objects from background clutter is that familiar objects relate more easily to the existing higher level
functional units than the background clutter. And for the same reason unlikely objects tend to be mistaken for likely objects.

The discussion on perception is ended with an example given by Jennifer Rogers in Adults Learning (Rogers, Jennifer, 1961) which perhaps demonstrates some of the questions raised:

TUTOR Well now, you've all read the second poem again, I hope. (Murmurs of agreement). One thing that struck me, one thing I'm wondering, did you see any striking difference between this poem and the last one we read.

STUDENT 1 It's longer! (Laughter and pause)

TUTOR Well ... yes!

STUDENT 2 Is it that this poem is somehow more ... well, not so personal, it seems to have less of Wordsworth himself in it?

TUTOR Yes. But I was thinking of something else.

STUDENT 3 The language is not so rich? Fewer metaphors?

TUTOR Yes, a good point. That's certainly true. We'll look at that later. Anyone got any more ideas?

STUDENT 1 I don't like it! (Laughter)

TUTOR Any more bright ideas? (Pause) Well, what I was thinking was that this poem is much more in the ballad vein, isn't it? It's reminiscent of the old simple Scottish ballads - can anyone tell us what a ballad is?

2.3.4 Imperfect Relationship between Cognitive Map and Reality

It is stated in postulate (c) that if the cognitive map relates, but only imperfectly, to the perception of an event then a motivation exists to render the relationship perfect. Two trivial situations regarding the relationship between a cognitive map and a perception may be disposed
of quickly before discussing the real issue. First situation, as already mentioned before, is that if no relationship is established with the event perceived then motivation to act is not generated at all. This happens, for example, when one sees a jumble of lines with no recognizable pattern in them, or one hears a few sentences in a foreign language. The second situation is when the relationship between the perception of an event and the cognitive map is perfect, i.e. when the recognition is complete. In this case also no motivation is generated to render the relationship perfect. However, both these situations are rare. For example when one sees a familiar face, one may see it at an unexpected time or place that one may start wondering "what is she doing here at this time of the night?" Thus most situations have a potential to influence the direction of action.

The concept imperfect is difficult to define. The expression cognitive dissonance has been used for this purpose. But the problem with this expression is that it seems to imply that there is an unpleasant perception. This certainly is not a necessary condition every time there is a perception of imperfection. Perhaps the concept of imperfection is best demonstrated by some examples.

A picture of the giraffe (below) has one line on the neck missing. In spite of that the giraffe is quite recognisable. However, the functional unit in a cognitive map represents a complete giraffe. The relationship between what is perceived and the corresponding functional unit is imperfect. In other words an imperfection may be perceived if the event perceived is incomplete.
In another example if one sees a motor car going along which is making a noise like a steam engine one will perceive an imperfection as the perception of this event does not relate properly to the cognitive map.

Another aspect of the imperfection is depicted by the following zeugma:

He killed a lion and two birds with one stone

Imperfection may be perceived in a relationship between the cognitive map and the perception of an event if it is incomplete, or if a part of it is un- or under-defined or if a part of it does not fit the whole according to the cognitive map of the individual.

Perception of imperfection can also arise out of experience of uncertainty. If a person is uncertain as to which of the various alternatives adequately relate to his cognitive map he may be motivated to look for more clues in the situations presented. Each alternative may offer a complete relationship but if all the alternatives taken together result in perception of imperfection then the individual will be motivated to act.

It is more difficult to define exactly sufficient and necessary conditions for the experience of imperfection than it is to recognise the situations which are likely to give rise to this experience. Further, once the course writer is adequately aware of this aspect of learning, it will be no major task for him to introduce elements in the learning sequence which will generate the required experience in the learners. This point is demonstrated in the analysis for writing of course material later on.

2.3.5 Learning

Consider a situation in which a person perceives an event, is unable to establish a perfect relationship between this perception and the functional units in his repertoire, and consequently is motivated to direct his efforts to improve this relationship. He may first search the rest of this repertoire to achieve this. If he succeeds he will probably get on with something else. If he fails he will then consider redirecting his efforts to investigate the reality itself. If he finds
that, the effort required to complete this investigation is more than what he is prepared to put in at that given time he will ignore the episode for all practical purposes. He may tell himself "I'll have a look at it in detail some other time" or "I have more pressing business to attend to", etc. However, if the motivation to act in this direction is greater than the effort required he will start the investigation. If 'enlightenment' does not take place before the motivation is exhausted the individual will again be inclined to divert his attention to 'more pressing business'. Provided sufficient cognitive motivation exists to complete the investigation 'enlightenment' will result.

What about learning? It is not too difficult to fall into the trap that the learning that has taken place is the additional information which was required to render the relationship perfect. This might well be the case in certain situations. However, most of the time what is learnt is whatever was necessary to learn to carry out operations enroute to this stage of 'enlightenment'. Supposing while reading a story a child comes across a word, which she is unable to comprehend, within a sentence which otherwise would make sense. She asks her mother to explain the word or the sentence. Her mother, for want of time or indeed knowledge, gives the child a dictionary, explains quickly how to look up words and suggests that she help herself. The child looks up the word and happily continues with her reading. Has the child only learnt the meaning of the sentence which was all she was motivated to learn? She may have learnt how to look up dictionaries, or indeed that there are such things as dictionaries (at all); she may have learnt at least partially the 'alphabetic order', etc. Depending upon the procedure she has to adopt she will acquire a whole lot of functional units which are not directly related to the imperfection at hand.

This kind of learning has sometimes been called incidental learning implying that it is not what the 'teacher' or the learner intended.

There are two remarks relevant to this statement. First, if the teacher is aware of the processes the learner is going to adopt the learning is not incidental, i.e. by simply changing the definition of the 'teacher' from one who states the objectives of a lesson to the one who states the procedures of learning one is able to remove 'incidental' content of learning. See for example L. Postman and V. L. Sanders (1946). This is
not to say that ideal teachers exist in reality, only that strictly from this point of view there is nothing intrinsic in the nature of learning itself that it can be tagged incidental.

On the other hand, from the point of view of the learner all learning is incidental, in the sense of acquisition of new functional units, since the learner, at best, knows what is learnt after it is learnt. The only thing that is not incidental is the direction the individual was motivated to put to his efforts. And learning does not take place every time an individual removes a perceived imperfection, except in a trivial sense - for example, when he winds his watch if it was reading half past nine and he had just caught the 1515 to Worthing.

To clarify further what learning takes place and when, consider the drawing of the incomplete giraffe again.
Suppose the following arrangements of activity are offered to various children in a learning situation:

(a) The line drawing of the giraffe is on a light box with the missing segment switched off. A number of press switches are provided; one of these switches will light up the missing segment. The activity is identifying the right switch from the clues given by way of symbols on each switch. A child, if motivated to complete the drawing, may spend some effort to remove the imperfection.

(b) The same arrangement as (a) but instead of switches some loose wires are provided. Connecting two wires will result in the missing segment lighting up.

(c) A child is given the line drawing on a piece of drawing paper. This time he can complete the picture by drawing in free hand the missing segment.

(d) The drawing is on a magnetic board with a flexible unshaped steel wire used to complete the drawing. The child has to shape the wire and cut it to size and fit it in the right place.

If these children had any doubt as to what a completed giraffe looked like then perhaps they will all learn the shape. (Whether they will learn the 'true' shape of a giraffe is not the question at this point.) However, the child in arrangement (a) may learn how to press switches, recognise symbols; the child in arrangement (b) will learn something about completing electrical circuits; in (c) the skill to draw lines; and in (d) the skill to shape steel wires. They will all learn something about the relationship between a whole and a part as well.

2.4 General

It is unfortunate that a great mass of research done in learning and its application has concerned itself mainly with animals with biological rewards as incentives or, when humans are the subject of an investigation with institutional learning often employing S-R approach. However there are some examples of research which are relevant to the 'cognitive' approach adopted in this dissertation.
One of the most under-appreciated piece of research in educational technology was carried out by R. F. Mager and its findings published as "On the Sequencing of Instructional Content" (Mager R. F., 1961).

"The purpose of this preliminary investigation was to determine whether a learner-generated sequence would be similar to an instructor-generated sequence, and whether or not there was any commonality among sequences generated by independent learners".

Following is the description of experiment and its results abbreviated from the original paper:

"To obtain learner-generated sequences, a procedure was developed which gave the learner control over a curriculum of instruction. A single learner, who had expressed a desire to learn something about the subject of electronics, was taken to a small seminar-sized classroom equipped with working tables and a blackboard. S was informed that he would be given complete control over the curriculum. It was explained that the instructor would try to behave only as a responsive mechanism, that he would offer information only in response to questions from S, and that he would continue to offer information and explanations until S asked him to stop or indicated that he understood. S was informed that he would be free to ask for information in any area of electronics, that he would not be restricted to any particular branch of the subject matter. (This procedure was followed to determine whether there was any commonality among learner-generated sequences even when no direction or specific objectives were offered by the instructor.) It was explained that S could ask for information, examples, demonstrations, problems, reviews or anecdotal material. The initial instructions contained three different references to the fact that the purpose of the experiment was to assist S to learn as much about electronics as he wanted to learn, that he was to be the sole determiner of the topics covered, and that he should continue to press the instructor for further explanations until he was satisfied. Finally, S was told that an instructional session would continue until terminated by him. Each session was recorded and later transcribed for study."
"it is difficult for an instructor, when asked a question by a student, to refrain from embarking on a dissertation designed to tell the student everything he knows. Instructors are not used to turning themselves on and off in response to enquiries from the learner, and it is a rather difficult habit to acquire. One might say that instructors are products of an instructor-generated culture. But this very fact highlights one of the more important results of the study. It is a simple matter for an instructor to present material in a sequence which is meaningful and "logical" to him. It is entirely another matter to present information in a sequence which is "logical" to the learner. If the instructor finds it difficult to keep up when the sequencing of content is controlled by the student, what kind of obstacles must the student be facing when the instructor controls the sequence.

Once the learner had become accustomed to the experimental method of instruction, evidence regularly appeared of a strong tendency on his part to associate new information with old. The learner showed by his actions that he was continuously looking for ways to tie new information to things he already know, and that these associations were sometimes correct and sometimes incorrect.

When an instructional sequence contains gaps for the learner, he attempts to forestall the collapse of the sequence, in terms of its meaningfulness, by recruiting material from his experience.

Once S appeared for the second session with a broken radio under his arm, and demanded to be told about the components he pointed out and about the part they played in the circuitry. He then asked to be told what steps should be followed to repair the radio, but would not allow the instructor to explain the second step until he had been allowed to understand and perform the first step. By the end of the instructional session, the learner had successfully repaired the radio and
was quite obviously pleased with his new-found skill. It must be emphasized that S was quite aware of the fact that this single experience did not make him an expert in the subject of electronics.

Other evidence relating to S's motivation is obtained from the length of the instructional session itself. According to comments made by the students, they terminated their sessions because they felt unable to assimilate more material at that time, rather than because they were bored.

Three observations relating specifically to the learner generated sequence of instruction are worth reporting.

(a) The learner begins his course in electronics with an entirely different topic than does the instructor. When the outlines of eight different basic electronics courses taught by industry or by the military were examined, it was found that all of them began either with the subject of magnetism or with electron theory. There is a good deal of commonality in the way most electronics courses are begun. If, on the other hand, an electronics course were sequenced by the learner, it would begin with the subject of the vacuum tube. All of the learners used in this preliminary investigation asked for information about the vacuum tube during the first 40 min. of instruction.

(b) There is some commonality between the independent content sequences generated by the learners, even though no specific objectives with respect to learning outcomes were provided, and even though they were not instructed to concentrate on, or avoid, certain areas within the very broad field of electronics.

(c) Although S tended to direct his sequence from the simple to the complex, for him this meant moving from a simple whole to a more complex whole, or from the general to the specific. For example, questions about how a radio works or about how a television receiver works preceded
questions about specifically what made it work. When questions were asked about components, the interest was always in function before structure.

The learner-generated sequence, in other words, more closely approximates the functional context method of content organisation than any other.

There were, then, several ways in which the learner-generated sequences were similar.

(a) Learners began their instruction with enquiries about similar content items.

(b) There was a similarity of content sequences during the early sessions.

(c) Initial interest was in the concrete rather than the abstract, in things rather than in theory, in how rather than why.

(d) Learners were interested in function before structure.

(e) Learners wanted to progress from simple wholes to more complex wholes."

Obviously Mager did not have a hypothesis, such as one implied in previous pages, which he was trying to test. However, the experiment can be interpreted to lend support to the advocated procedure of learning.

Brief mention may be made of another experiment, done by Birch and Rabinowitz (1951) demonstrating 'inhibition' in using an object in one function due to recent use of the object in another function:
"... two-string problem was given with both a small electric switch and a small relay available as weight for making a pendulum of one string. Prior to the problem, some Ss used the switch to complete a circuit, some used the relay, the control Ss waiting. Those Ss given circuit-completion experience tended to use the alternative object to solve the two-string problem, whereas control Ss used each with equal frequency. This demonstrates functional fixedness."

The concept of cognitive map may be compared with Skemp's idea of Schema. "The general psychological term for mental structure is a schema. A schema has two main functions. It integrates existing knowledge, and it is a mental tool for the acquisition of new knowledge. (Skemp 1971). So far so good. There seems to be a general resemblance between the cognitive map as described earlier and the concept of schema. There is however a major difference between the two concepts. Skemp seems to be suggesting that the element of schema somehow resembles the existing educational disciplines remarkably well. He suggests that "Almost everything we learn depends on knowing something else already. To learn aircraft designing we must know aerodynamics, which depends on prior knowledge of calculus, which requires knowledge of algebra, which depends on mathematics". Further Skemp's schema seems to be an artifact contributed by teachers to teach rather than an assumption that people naturally learn using schema as a tool. Inspite of this major difference, the actual utilization of the two concepts in teaching and learning is very similar."
# Chapter 3

**An Experiment: Teaching Children to Read**

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3.1 Introduction

Assuming that a method which people employ to learn is successfully discovered, it is still a far cry from the statement of a method based on this discovery which teachers may employ to teach. Formal definition of such a method of teaching is described in the next chapter. In this chapter an experiment, which the author conducted with children who had reading difficulties, is described. This experiment was originally conducted for an informal assessment of the method in the Spring Term of 1972. Proper record of the procedures was not taken as the full implications of the unexpected success were not realised for some time after the experiment was completed. The experiment was repeated in the Spring Term 1976 with the collaboration of the Headmaster, Mr. Grimwood, and Mrs. Margaret Mitchell who was responsible for remedial teaching of reading for some classes in Malmesbury Middle School, Morden, Surrey. This experiment is described here partly to 'bridge the gap' between the method of learning defined in the last chapter and a method of teaching stated in the next chapter, and partly to give the reader a respite from reading more abstract contents of this dissertation.

3.2 The Experiment

3.2.1 General Information

3.2.1.1 The School

Malmesbury Middle School, Morden, Surrey (London Borough of Merton)
Pupils during session 1975/76
Mixed ability, both sexes, age range.
Headmaster: Mr. K. J. Grimwood
Remedial Teaching of Reading

When the children start the Middle School at age 9+ years their reading ages are measured within two months. On the basis of this result and the reports from the Primary Schools, children are selected for remedial teaching in reading. Throughout the stay of children in the Middle School reading ages are measured periodically. Those children whose reading ages improved sufficiently were sent back to normal English lessons. New children who showed below par progress in their reading were included in an existing remedial class or new remedial classes were formed. Generally the remedial classes were restricted to ten children and generally from within the same normal class. Children from different normal classes were rarely included in one remedial class and children from different years were never included in the same remedial class.

3.2.1.2 The Experiment

Collaborating Teacher: Mrs. Margaret Mitchell

Duration of the Experiment: 15 weeks including two weeks of the Easter Break (3 March 1976 to 28 May 1978) - a total of 25 half hour lessons.

Remedial classes are timetabled for three half hour lessons per week. Some of the lessons are cancelled due to other duties of the teachers and children stay in their normal classes. During this experiment this plan was kept. Out of a total of 31 timetabled lessons, 25 were actually taken by Mrs. Mitchell and 6 were cancelled.

Sample: 10 children
(Note: One child was placed in the remedial class making a total of 11 in the class, but was away for most of the lessons (15) and is therefore ignored for this experiment.)

To maintain the anonymity of the children their names are not published. They are instead identified by symbols A to J. In Table 1 (b) stands for a boy and (g) for a girl. The date of birth of each child is given in column IV, the calendar age as at the start of the experiment.
(3 March 1976) is given in column V and their reading ages on that
date in column VI. All figures are given in decimal notation for ease
of manipulation later on rather than as years followed by months as in
common practice in representing reading ages (e.g. seven years and nine
months is represented as 7.75 instead of 7.09).

Calendar and Reading Ages on 3.3.76

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<th>I</th>
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TABLE 1

Reading Scale

Since the idea of this experiment was to assess the effort of the new
procedure based on the method as described in Chapter 2, as compared to
the existing approach in the school on the progress children make on
reading, it was decided to use the Holborn Reading Scale which the school
had used for some time past. The previous record of the reading ages of
the children in the sample was based on this scale.
3.2.2 The Procedure

3.2.2.1 Introduction

At some point during an application in a classroom situation an educational technology becomes an art. Whereas the procedure adopted is entirely based on the postulate stated in the last chapter, it was adopted to take into account the realities of the classroom, the personalities of the children and others involved and the time and resource available.

Reading was defined as recognition of written symbols which represented existing concepts in the cognitive map of the children. The new functional units, therefore, which the children had to acquire were not recognising written symbols for new concepts but for the existing ones. Children were learning to read rather than reading to learn.

To identify the cognitive map of each child and the collective cognitive map of the group children narrated their own stories into a microphone connected to a tape recorder. These stories were transcribed and bound in the form of a booklet. To introduce an imperfection in the relationship between their cognitive map (their stories) and what they saw (the written stories) they were simply asked to open the book at their own story. According to this method the children should be motivated to remove this imperfection. The channel open to them to achieve this was to try and read their stories. This is what in fact they were asked to do. When a statement is made that a child has a reading difficulty it is not implied that the child cannot read any words at all. Quite often the child has difficulty in identifying the relationship between words of a sentence. However if the sentence is originally his own, the child should not feel this difficulty. Care was taken not to alter, while transcribing, anything at all in what the child recorded. While reading, the only new activity the children entered into was to recognise written symbols for the functional units they already possessed in the form of concepts. The children were asked to read other stories in the booklet after they had read their own. Without any prompting from Mrs Mitchell the children read the stories to their parents!
The procedure was repeated twice. The first time the transcripts were an 'improved' version of the children's recording. The second time the written stories were vaguely based on the recordings.

The fourth booklet of stories was written entirely in Standard English but based on what was understood to be the collective cognitive map of the group.

A letter written by Mrs. Mitchell one week after the start of the experiment is reproduced here as it says something about the reaction of everybody involved:

Malmesbury
Monday 15/3/76

Dear Mr Makkar

Many thanks for booklets which the children were very pleased with. All present on Friday, took them home with pleasure. 'D' had a pair of shoes as a reward which he has since split playing football! All parents seemed to have reacted well and most of the children have read the stories to their parents. Herewith reading ages I forgot on Friday - sorry. Next lesson tomorrow!

Yours sincerely
Margaret Mitchell

3.2.2.2 Distribution of Labour

During the experiment, Mrs Mitchell carried out most of the work which related to the implementation of the procedure in the classroom. She recorded all the stories and transcribed them in long hand. She conducted all the lessons except three which the author took himself. She conducted the three reading tests and the one fluency test. Three meetings between Mr Grimwood, the Headmaster, and the author and five meetings between Mrs Mitchell and the author took place at various points before and during the experiment.
As it turned out the experiment took place in five phases, each lasting one to seven weeks. Each phase is described below.

**Phase 1**
1 week, 3 half hour lessons

1 **Measurement of reading ages**

This was done on Holborn Reading Scale. Although this scale employs a structure of sentences which was not natural to the children taking this test, it was decided to use this scale as it was used by the school to these children for the whole of the period, some 17 months, since they started in this school. Although not a completely satisfactory scale, it would provide a good comparison between the progress the children made during the experiment with their past performance.

2 **Children narrated stories which were recorded on a tape recorder**

Children were invited to narrate stories from their own experience or any others for the purposes of recording and later on for transcribing. Although there was some doubt if the children would be forthcoming to do this in the presence of the rest of the group. In fact in the event they were quite keen to tell their stories. The stories were rather short and the standard of English not high. But the flow of ideas was discernable. The transcript of these stories and others used in this experiment are given as an appendix to this chapter on page 74.

3 **The stories were typed, as given, and bound as a collection in the form of a booklet (Book 1)**

Margaret Mitchell transcribed the stories in long hand as it was felt that she was the best person to interpret what the children actually said. These stories were typed and bound as Book 1. Each copy of the Book 1 started with a different story so that the copy which a child received had the first story of his own.
followed by others. This was done to reduce the effort required to find their own story when their motivation was at its highest to actually read it.

The final transcript was as near to what was actually recorded as possible. No attempt was made to improve grammar, insert pauses where there were none, etc.

Children were asked to read their own stories 'privately'.

Children were given these books and asked to read their own stories. They were asked to read their own stories 'privately' at first as it was felt that, because of their history of failure in reading, they might have to overcome an unnecessary hurdle.

Margaret Mitchell invited volunteers to read their own stories to the group if they so desired. Care was taken not to imply any approval or disapproval in this invitation. In retrospect it seems that this precaution was unnecessary as all the children were dying to narrate the stories. All the children narrated their stories to the class.

Margaret Mitchell was asked to underline any words with which each child had any difficulty, and to take note of any comments children made on a spare copy of the stories. Little girl 'A' tried to correct her own grammatical errors and found it awkward to read with the 'mistakes' in. 'I' was slow in reading. Apart from that out of the ten stories children had difficulty in reading only seven words from their own narrations.

Children were asked to read each other stories if they so desired

All the children read some stories of others.

Children were allowed to take the Book 1 home

They were not asked to either read the stories to themselves or to their parents. From the feedback, however, it was found that they read the stories to their parents and the reaction of the parents to what they saw was good.
Phase 2
1½ weeks, 4 half hour lessons

8 Children were asked to record another set of stories

Having succeeded once the children were quite enthusiastic about recording the stories again and were a lot more confident. This is obvious from the length of the stories and their complexity.

9 The stories were transcribed in the form of Book 2. Some of the more obvious grammatical mistakes were removed and the punctuation improved.

The stories as narrated were an improvement on the first stories told but they were further improved as the object of this experiment was to improve the children's reading of Standard English.

10 Children repeated the steps 4, 5, 6 and 7

Children read their stories 'privately' first, then each others and finally to the rest of the class. It was already obvious that the reading was improving. No reading tests were conducted at this stage as it was important that the children did not get used to the script of the test itself. Children were allowed to take the Book 2 home.

Phase 3
3 weeks, 9 half hour lessons

11 More stories were recorded.

12 The stories were retold and compiled as Book 3

The stories this time were retold in more Standard English. The original situations were maintained to some extent. This was, perhaps, the first step for children to read something which was mainly not their own. Even so a great care was taken to tell stories with which the children could relate.
Repeat of the previous procedure for reading

Children were reading quite well at this stage, obviously some better than others.

Measurement of reading ages

It was felt that the time had come to measure the reading ages again to see if children had made any progress. The reading test was conducted by Margaret Mitchell on 7 April 1976 some five weeks after the start of the experiment. These reading ages are given in Table 2. Children's reading ages as on 3 March 1976 at the start of the experiment are also given for comparison.

An average gain of 0.2 years in reading age as compared to the rise of 0.1 in calendar age. Not a spectacular result but it should be compared to the gain of one month in reading age during the 17 months immediately preceding the experiment. The figures for the previous 17 months are given with the results in Table 3.

<table>
<thead>
<tr>
<th>I</th>
<th>II Child</th>
<th>III Reading age at start of scheme</th>
<th>IV Reading ages after 5 weeks</th>
<th>V Gain</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>A</td>
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<td>B</td>
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</tr>
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<td>3</td>
<td>C</td>
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<td>8.50</td>
<td>nil</td>
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<tr>
<td>4</td>
<td>D</td>
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<td>5</td>
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<tr>
<td>9</td>
<td>I</td>
<td>6.50</td>
<td>6.75</td>
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</tr>
<tr>
<td>10</td>
<td>J</td>
<td>9.25</td>
<td>9.60</td>
<td>0.25</td>
</tr>
</tbody>
</table>

Average 8.38 8.58 0.20

TABLE 2
Rise in Reading Ages after 5 weeks
A Book 4 of stories was produced this time without the able help of the children.

Book 4 contained eight stories in Standard English. The situations deal with were 'ordinary' rather than violently dramatic. One could say that reading with facility of the English by the children was the 'aim' of this effort.

Children were not asked to read Book 4 during lesson time in the first instance, but were given this book to take home for the Easter Vacation. However, there was an obvious underlying expectation that the children would read them.

**Phase 4**

6 weeks (including 2 weeks Easter holiday)

Two weeks holiday. Children read some stories at home.

The only significant point to note at this stage is that children came back after the holidays with their enthusiasm in tact.

Children read stories from Book 4 for the next three lessons

An unforeseen event took place at about this time. Children were getting too sure of themselves and suggested (demanded is more accurate) that they be given work sheets based on the stories. Reality of the situation commanded that this be done although it was not thought necessary at the planning stages.

One lesson with a comprehension test for the story "Sam's Seeds"

A comprehension test of five questions was hurriedly produced. All the children scored full marks. It was decided that this was because the test was too easy. The effect on the children, however, was not bad. One feedback via the grapevine was that the children in the group were talking about their reading during the breaks.
This result is given in Table 3 on page 70 along with other results. Suffice it to say that this time the average gain in reading age was 0.92 years for 0.42 rise in calendar age.

**Phase 5**
2 weeks, 4 half hour lessons

The experiment as planned would have ended at this stage except for another unforeseen circumstance. Margaret Mitchell and the author, who had taken some lessons himself by now, both felt that the children were reading more fluently than before, in addition to recognising more complex sentences. The test employed did not overtly measure the fluency, only recognition of rarer words. To form some idea of the gain in fluency the experiment was extended by two weeks in spite of the fact that Margaret Mitchell was extremely busy with other duties attendant upon all teachers near the half-term of summer.

21 Three lessons with two comprehension tests

The tests were made progressively more difficult. On the test for "The Weekend" the children scored an average of 93% and on the one for "The Picnic" they scored 90% average.

22 Fluency test

There were many things wrong with attempting to measure fluency. First there are no standard tests available publicly for this purpose. And there was not the time to design a new test and validate it. There were obviously no records of children's previous performance in fluency. However it was decided that an attempt should be made in spite of all these difficulties, at least, to form some opinion on this score, though not too much reliance could be placed on the results either way.

Margaret measured the fluency entirely subjectively on a scale 1 to 10 as defined below:
1: sounding out most words
10: no hesitations

It was decided that Margaret Mitchell would 'guess' what the fluency of the children was at the start of the experiment. The result is given in Table 5 on page 72 with the rest of the results. The average fluency rating rose from 4.5 on 3 March 1976 to 7.1 on 28 May 1976.

23 Eight out of ten children went back to normal class.

Not too much should be read in this fact as some of these children would have gone back to the normal class even if they had not shown any spectacular rise in reading age.

3.2.3 The Results

The results are first given in the form of tables followed by graphs of these results and explanations. Discussions and implications for the Method of Learning form the next section.

Table 3 gives the reading ages of the children from the time they entered the Middle School in 1974 through to the end of the experiment (all measurements on the same scale).

Table 4 gives the fluency as 'guessed' on 3 March 1976 and as 'measured' on 28 May 1976. It is assumed that the fluency was 1 i.e. the minimum possible if the children can read at all in October 1974 when they first entered the school.

Table 5 gives the results of the Comprehension Tests.
### Reading Ages

<table>
<thead>
<tr>
<th></th>
<th>I</th>
<th>II</th>
<th>III (Oct 1974)</th>
<th>IV (Apr 1975)</th>
<th>V (Sept 1975)</th>
<th>VI (Jan 1976)</th>
<th>VII (10.3.75)</th>
<th>VIII (7.4.76)</th>
<th>IX (18.5.76)</th>
<th>X (Gain in Reading Age)</th>
<th>XI (Rise in Calendar Age)</th>
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**Table 3**
Average rise in reading age

Size of sample 10

- Actual performance
- Average for last 17 months
- Projection based on seasonal fluctuations

Graph 1

COMPREHENSION TESTS

<table>
<thead>
<tr>
<th>Child</th>
<th>12.5.76</th>
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<th>26.5.76</th>
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<td>I</td>
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</tr>
<tr>
<td>10</td>
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<td>10</td>
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</tbody>
</table>

Average: 100% 93% 90%

TABLE 4
The results of the fluency test corroborates the results of the test on reading ages.

**TABLE 5**

<table>
<thead>
<tr>
<th>Child</th>
<th>Fluency in Oct 1974</th>
<th>Fluency in March 1976</th>
<th>Fluency gain in 17 months</th>
<th>Fluency in May 76</th>
<th>Fluency gain in 3 months</th>
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<tr>
<td>2 B</td>
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<td>3</td>
<td>2</td>
<td>5</td>
<td>2</td>
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<tr>
<td>3 C</td>
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<td>6</td>
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</table>

The rise in fluency and size of sample 10.
The results of comprehension tests only confirm that children were not reading better and more fluently, but also were understanding reasonably well what they were reading.

Graph 1 represents the figures given in the last line of the Table 3, i.e. the average reading ages of the children in the group at various times during the previous 17 months. Following points may be noted in the graph and the table:

(a) During the 17 months preceding the experiment there are two periods in which there was no rise or no significant rise in the average of reading ages. These seasonal fluctuations may be due to vacations or due to some unidentified cause. However based on this fluctuation the expected gain in the reading ages of the children would have been nil. In fact there was a gain.

(b) The average gain in reading age during the previous 17 months was 1.12 years per calendar year and 3.38 years gain in reading age per calendar year.

(c) The increase in the rate of gain in reading age during the latter part of the experiment may be due to children's experience of success in reading, and due to their not being used to this method of teaching during the first few weeks of the experiment. In any case there seems to be a threshold which children crossed some time during the Easter break.

Graph 2 represents the gain in fluency rating of 1 as guessed in October 1974 to 4.5 also guessed in March 1976 to 7.1 as measured in May 1976. There is not much to read in this graph excepting perhaps that there was a tangible gain in fluency rating. Also there does not seem to be any correlation between reading ages or gains in reading ages with fluency rating or gains in fluency rating for the children in the group.

3.3 Implications

The reason this experiment was undertaken was to confirm the method from outside the field of Computer Awareness. However, there are some
similarities between learning to read and the acquisition of CA. Both are concerned with day to day living rather than with any specialist profession. Both can be acquired naturally if the right environment exists. Both can be considered remedial activities - reading because children involved did not get the right opportunity to develop this skill, and CA because the opportunity to acquire it naturally does not exist for many in practice. That is to say that the development of CA is lagging behind the development of general awareness for most children just like the development of reading is slow for some children.

3.4 Appendix to Chapter 3

To make this chapter complete this appendix is provided at this place. The main appendices at the end of this work concerns only CA.

3.4.1 Book 1

Children's own stories transcribed as recorded

'A'
Once upon a time there were a girl and boy they were lost in the forest they could not find their way home and they were deep in the forest Their father called. They called back to him Their father found them and they went back to their house and they never ever went back to the forest again.

'B'
An extremely odd planet called Cumber There are blue midgets and green midgets and they all live in little holes in the ground.

No one knew about Cumber before our class discovered them.

One day that class went up to see the planet Cumber and they were enjoining themselves until one person had an argument with a blue midget and an elastic person.
Cumber is very extraordinary half of it is white and half of it is black. Most of the people are extraordinary cos they don't all live together in one family.

'C'

I went to the circus with my dad and mum and my brother. We saw some clowns and it wasn't half funny. Then we saw an act on a trapeze that wasn't half daring doing all them somersaults in the air. Then we saw a tight-rope walker. Then we went hom and had some tea.

Next day I went out with Joe to Joe's house then we played football then Martin came along. He went on Joe's side. Then we said "Lets go and look for David Philips" so we looked for Philips. We wanted one more for two aside. Then it was about one o'clock on a Saturday so we went back to our houses and had our dinners.

Then we went to the pictures and saw "Jaws". It was very good.

'D'

One day Me Pete Joe and Christopher went to see this picture and it was called "Jaws". It was really exciting because we saw blood and things like that. And then after that we went to see a football match and that was against Chelsea and Crystal Palace. Crystal Palace won two nil. But we got lost. We got a Red Rover and then we still got lost we go on the wrong buses Our mums and dads were worried 'cos we didn't know our way home. They knew we were going to a football match. Then one of us got knocked over. That was Joe. Joe went to this hospital and then we had to stay there for the night. And then Joe had two broken legs and one broken arm. So then it wasn't very good 'cos our Mums and dads came and found us. The police informed them. But Joe was very badly wounded and the car driver was very badly wounded as
well cos from shock. So Joe got better and so we went home.  
And then we lived happily ever after.

'E'
Once upon a time there was a girl and her horse. Her horse was named Daisy. She loved the horse very much he was white as snow. One day she went to school she came back and saw he had disappeared from the farm Then she started to cry because she thought the horse would die or get run over by traffic. Then she ran upstairs and told her mum an dad and they went and told the police.

The police looked all over the field and found that she was in the shed dead and starving and freezing cold. The girl was very sad and she started to cry. Her mum got her another horse and she loved it very much. She loved the first horse.

'F'
On the fourth of January two boys were found to be missing Peter and Paul. Two search parties went out to look for them but they could not find them. They found two rucksacks a piece of blue material and the next day they carried on searching.

They found them in a ditch down by a bush.

'G'
The Football Match
One day me and my brother went to see the football match Chelsea v Tottenham. Tottenham won 6-2 Then my dad said do you want a drink and I said yes Then I had my drink and we went home by a bus Me dad said "Do you want a game of football?" and I said "yes". We went over Chelsea's football ground. Then Peter come and Martin and David Martin said "can we play?" and I said "yes" "Me Peter and me dad against you lot" Then we played. We won 7-2 Me dad said "It's time to go home" and I went home a dreamed about it. Peter said to me two nil and I said yes. We
went to school and played football again and then the bell went for home time.

Then we went home and Peter said do you want a game of snooker and I said yes and he beat me. We went home and asked my mum if he could stay for tea and she said 'Yes'.

Next day we had games and played football as well the score was eight all when the bell went.

'H'

One day there was a little girl called Angela and she loved horses. One day she went to her father and said "Could I have a horse?" Her father said you'll have to wait for your birthday. So that night when Julie went to bed she was thinking about the horse. She was dreaming how she's love the horse and to ride it and one day be a show jumper. The next morning Julie had to get ready for school. She packed her things and said goodbye to her family.

Her teacher said "I want you to write a story about anything you like". Julie wanted to write about horses. so, she wrote down the dream she had and she wrote about the horse. After she had finished she went to the teacher and she marked it. After that she was still worrying about if she would ever have a horse or not. But I think the dream came true.

In the afternoon when she came home her dad said "Go into the farm and look what you have got" and there was a lovely white horse. And then she went up to it and then she wanted to ride it. She's going to call it Daisy.

'I'

Once upon a time there were two children called Tom and Stacy. they were walking down the road when they stopped and picked some flowers for their Nan. And on the way saw their Nan
Then they had to go in for their tea then they went out to play again. Then their dad said they had to come in for their bed then they opened their curtains and said it was raining. They said could they go down the road for some one to play with. But their Nan said "No" because you might be going out with your Nan to see the shops and the park.

'J'

Once upon a time there was a girl picking flowers. She picked this flower and put it in some water when she got home. And it grew so big and a little man came out. It was a genie it gave her three wishes.

So one day she did the three wishes. One of them was that she could live in a big country house and another one that she could marry a beautiful prince but this wish didn't come true because she was horrible to the genie. The next day she threw the flower away because it was dead she hadn't given it any water. So none of her wishes came true.

3.4.2 Book 2

Children's own stories, English slightly improved. Child 'A' was absent during this recording session. Her story from Book 1 was repeated in Book 2 so as not to make her feel left out.

'A'

Once upon a time there were a girl and boy. They were lost in the forest. They could not find their way home, and they were deep in the forest. Their father called. They called back to him. Their father found them and they went back to their house, and they never ever went back to the forest again.
Once upon a time there was a baby horse and his mother died. One day a girl walking in the woods saw the horse. She took the horse home and her mother said that she could keep him.

It cost her a lot of money to keep him all week and every day, so they decided they would get rid of the horse. But the horse wouldn't go. He kept coming back every time. And every time they had to make a long journey back to the farm. So they decided that they would never get rid of the horse this way, so they moved. And bought another little horse which didn't cost so much than what the other horse did. But she still loved it as much. And they called the horse Snow White because it was as white as snow.

One day there was a fire down my street. I went to phone the fire brigade and after about five minutes they came. And this house was blaring with fire. My dad's Station Officer of that fire station and it took them about two hours to put the fire out. Then he went back to the station and phoned me up. He said "We put out the fire down our street" and next day he came home. The people were homeless in that house.

Then we went to the pictures and saw 'Return of the Pink Panther'. It was really good and there was kung fu in it and great big jewels stolen. Then we went home and had some tea.

Next day he took me to a football match. It was Stoke v Chelsea. Stoke won 8 nil. Then I went home and had me dinner. Then me mum went 'Bingo'. That was all really.
At the banger-car race me, Joe, my Dad and Peter. My Dad took us down to this banger-car race and me Uncle was driving. My Uncle had an accident 'cos a car hit him, he went through the windscreen.

He was very badly wounded and the ambulance came and took him away. When they got to the hospital he was dead, but my Aunt and my other Uncle they come down to his funeral. But he wasn't dead; they thought he was but he wasn't. So my Dad brought him back to his house and then he was just sitting there and then my Uncle died properly then, and the next day we had the funeral. And then Joe and Peter, we went out to have a game of football, and then it was about half past one on a Sunday, and then we remembered my Uncle's crash and then we started playing on our bikes. When we had our bike race it was funny 'cos one of us fell off and hurt ourself. Then we got in a proper car with me Dad and then he took us down to where my Uncle was buried, about a weeks time later. Then we went to the zoo. We saw this baby elephant being born and then its mother stamped on it by accident and then that one died. And then it reminded us of my Uncle and then we went the next year and saw my Uncle and then we remembered about him.

This story happened 40,000 years ago. There was once a girl called Julie and she was walking in the woods, and suddenly she fell down a ditch. She found herself in a mysterious world. There in front of her stood a mysterious man. He said he was a magician and she said "Why have you got me here?". And he said "Your mother is a witch and you must kill her". The girl started to cry and the magician told her that if she didn't kill her mother he would kill her. So she ran back home again and that night she went into her mum's bedroom and killed her. And then she ran away and didn't come back.
The Circus

One day I went to the circus with my Mum, and Dad and brother. First we saw the horses. They went round and round the ring. Then we saw the clowns. They had custard pies and one of them pushed a custard pie in the other one's face. Then we saw the elephants. Then we saw the acrobats and one of them went up and he swung on the trapeze, and another one caught him. After that we went into the back and saw all the animals.

The Fire

One day me and Peter and Martin and David, we was playing football when we saw these three boys. They was smoking. We told their mums and dads and their dads told them off.

Peter said "What shall we do?". Martin said "Let's start a fire". We all said "Yes". So we went to the woods and lit a fire.

It was burning and we couldn't put it out so we just run. This lady come and saw it and phoned the fire brigade. The fireman said to the lady "Did you see it?" She goes "Yes". "Do you know who done it?" She goes "No, but I saw these three boys running. They live down my street, Peter, Joe and Martin, and David". And the policeman told the lady "Where do they live?" and she told them. Then the policeman knocks on our door. He said "Can we take your children to the police station?" Peter's mum said "Why?" He said "Because they lit a fire in the wood and we had to get all the fire brigade on to it. We only just got it out just now. So we went to the fire brigade, and our dads said "Where's Peter, Joe, David and Martin?" Their mums said "They've gone down the police station". So his dad went down the police station and he said "What's the matter?" to the policeman. He goes "They lit a fire". Their dads got fined £50. They went home and went to bed and had some tea.
Next day they played football. Their mums said "You can come in now and watch telly". We went and watched football on telly.

Next day we all went to school. We played football, we had Maths, English, Social Studies and German.

'H'
The Magic Flowerpot
There was once a little girl called Juliana. One day, she went over to the woods and played. Then suddenly she found an old box by a tree. She picked it up and she brought it home. She tried to get some glue to stick it on. So after a while she came back and there was a giant plant. She never put any seeds in it and she never put any water in it. And now it was just an ordinary tall flower. She went downstairs and she cut the flower and put it in the pot. The night a flower grew again. She didn't know how it grew. So next morning she cut it again, but it kept growing. She told her mum that the flower kept growing, and so she said "Well throw it out and just leave it in the garden, then it won't probably grow". So she did what her mum said. That night she looked out the window, nothing was happening. In the morning she was covered in plants all over the place.
Her mum went furious. She said "You get out of this house and you tidy all these plants up all over the place". So she was ten hours trying to get all the plants undone. And by the end the pot started to die off. When it had died off the girl was sad. She wished that it was a dream really, but her mother said that if she finds anything more over the woods never to bring it home.

'I'
Once upon a time there was one child. Her name was Tracy. She lived nowhere 'cept she lived in the woods all the time. She had nowhere to live and nobody to play with.
One day she found a horse in the forest where she'd been walking all the time. She saw a girl riding it and she asked her what was her name, and what was the horse's name. Then that girl asked what her name is, and she said she didn't have a name 'cept that they all call her Daisy sometimes and Tracy sometimes. And then they always played with each other except that she had nothing to eat. When that girl come out she saw that Tracy was laying on the ground cold and without things to eat.

Once upon a time there was a girl and her dog called Snowy. One day they were moving and they were going on a train. The dog ran out of the train when she opened the wrong door, so she tried to stop the train: when it stopped they would not go back to see if it was alive.

So one day when she was going to a boarding school she got on the train. She got off at the wrong station and went to look for the dog. She asked all the people if they'd found it. Then the next day she bought a map to see where her old house is 'cos the dog might have gone back. On her journey she met this girl who gave her a bike to ride on. And the police were looking for her because the school telephoned her mum and said she was missing. The next day she saw an ambulance and these two ladies was talking about a dog being run over. So she ran to the vet and Snowy was there.

3.4.3 Book 3

Children's own stories. Only the situations from the original recordings were kept. The stories were changed and the English standardised.

'A'

The Girl and the Rat

Once upon a time a girl was playing in her shed. Suddenly she saw a rat come out from under another shed. She went to tell her mum, and her mum said, "We'll have to get some poison to get rid of it." They tried to get some, but they couldn't
get any. The next time a rat came out her mum killed it with a stone. Then she got some of the poison and put it under the shed, and they never saw any rats again.

'B'

The Horses
One day when we were on holiday my mum, my two little sisters and I went horse riding. We went to my mum's friend Carol, who has got two horses named Woody and Pickles. Her daughter Alison gave us all a riding lesson. My youngest sister, Gillian, rode the horse five times and jumped over three sticks.

My other sister, Alison, rode the horse around for two hours. I rode Pickles who sometimes bites. This is because his last owner whipped him. Alison and Gillian weren't allowed on him, but I was. I rode round five times, jumped five stands, and then went to the park on him.

Pickles is a very strange horse as he is tall and thin, but Woody is very nice, small, fat, and very calm. I took Woody back into the stable and took off his saddle and reins. I gave him some water and brushed him down, and he went to sleep. Then I helped Alison Lake brush Pickles down and he went to sleep. We all went in to have our tea and then went home.

'C'

Visit to the Fair
One day, Joe, Martin and I went to the Fair. We went on the Ghost Train, and Martin fell out of the car. So we told the man who came and got him out. Martin was scared, so then we went home to tea. Later they came to my house and we watched 'Policewoman' on television. Then we went to Wyvern and had some fights on the mats. Then Joe and I had a game of table tennis, and I beat him 21 to 20. We played on the football machine, and then walked home. On the way we bought chips and a drink from the fish shop. When we got home Martin saw my dad's new car, and said it was a good one.
Next day at school we had Games, and I scored about six goals. Martin scored three, and Joe was the goalkeeper. Then David said, "Are you coming swimming tonight?". I said, "Yes, because Mrs. Mitchell gave me a free swimming pass". So we went swimming, and I swam about six lengths and did a few dives. Then I went home for my tea.

'D'

The Fair

One day Peter, Joe and I went to a funfair. First we went on the bumper cars which was good. Then Joe found a pound, so he took us on the Octopus which we liked, and then Joe got a ring round a box and won five pounds. So we tried everything and kept on winning.

Later we went to my house for something to eat and then played football. We played two-a-side because David Philips came along. They won two-nil, and then we went for a run. We went home and asked our mums if we could go to a football match, and they said "Yes", so we did.

On the way home we went to the funfair again, but this time we didn't win. We lost about 25p each, so we went home.

Next day we went to the football match again, and played about with the ball.

'E'

The House with the Secret Treasure

There was once a man and lady who were trying to find a house. They found a nice house in the country. On the day they moved in the man lifted up the old carpet to put down the new one, and found a secret door. He opened the door and went down. It was very dark but he found a chest with some gold in it. He ran upstairs to tell his wife and they thought they would be rich.

As they were going out to take it to the Mayor they found a witch standing outside the door. She said, "If you don't give me that gold, I will put a curse on you". But they said, "No,
it's our gold and we're going to take it to the Mayor and get rich". The witch was furious and she went off on her broomstick, but she came back the next day.

She said, "What have you done with my gold?" The man didn't answer, so she put a spell on them to make them leave the house, and the witch got the gold back.

The Ferrari

The Ferrari 3/12 B 3-1974 can reach speeds of up to 202 miles per hour. It has twelve cylinders, a cubic capacity of 3,000 and horsepower of 350.

The race was on. I zoomed past the first lap, then another car from the inside cut across in front of me and forced me off the track. I crashed into a tree and the car caught fire. The fire engine came and put out the fire, and the ambulance took me to hospital, where I stayed for three months until I was better.

Then I went in for the Le Mans race, and came first in that. But on the Le Mans track one of my friends was killed, and I was very sorry about that, so then I retired from racing.

A Day at School

One day I knocked for Peter at a quarter to eight. He was ready, so we went to school and played football. When we went into school we had two lessons of English before play, and then French. At dinnertime Paul Thronton, Peter, David, Martin and I played football against the third years. They beat us 3-2. In the afternoon we had Social Studies and then went home. Peter said, "Do you want a game of football?" I said, "Yes", so we knocked for David Phillips to come and play football with us. Later we had our tea and then played football again.
After that we played hide-and-seek in the garden, and Martin
came and said, "Can I play?" We all hid in the dustbin, but
we found a hole there which led underground. There we saw
an old man with curly hair, funny boots and a hat. He said,
"What are your names?" We told him, and he gave us some tea.
He asked "How did you get here?", so we explained about finding
the hole in the dustbin. He asked us if we knew how to get
out. We didn't, so we were there for a long time. Then the
police and Kelly found us.

The next time we played hide-and-seek we climbed a tree to hide
in my tree house. We went down inside the tree stump and saw
the man with the curly hair and funny boots again. He gave
us some tea. Later, everyone was looking for us, and Lee,
David and Kelly found us.

Next day we agreed to play football instead of hide-and-seek.

"H"

The Wizard

Once a little girl called Susan was walking through a thick
wood when a man suddenly appeared in front of her. He was a
wizard and he told her that he would keep her a prisoner, to
do jobs for him. He took her to a cave and kept her there
for two days. She was very nervous. Then the wizard came
and said, "Do all the work for me". She had to do the cleaning
and cooking and then go back into the cave.

The next day she had to work for him again. She was covered
in mud where she had been lying on the floor, as there was
no hay to lie on. The wizard told her, "You must stay here
for ever". He kept her in the cave for a month, and she grew
as skinny as a bone, but he said, "Right, you are big and
strong now to do the work". She was too tired to do anything,
but the wizard kept telling her to do all the work, and keep
the cave tidy all the time. She hadn't had any food for a
month so she was very hungry and weak.
Her mother was very worried and called the police who looked everywhere. Suddenly a policeman saw the wizard in the middle of the woods, so he asked him, "Have you seen a girl anywhere? She's quite slim and has long hair". The wizard said, "I haven't seen anybody around". Then the policeman heard a noise. "Help, help", called Susan. The policeman tried to track where the voice was coming from, but the wizard said, "There's no noise here, it's probably someone mucking about".

After a while the police were all around the forest, and then the policeman heard the noise again, "Help, help, help, help", and they found the cave. They opened the cave and there was Susan lying there, very weak and hungry. They took her to hospital and gave her food until she was feeling better.

The wizard was sent to prison for five years.

"J"

The King's Three Sons

Once upon a time there was a king who had three sons. The king was getting old so he said to his sons, "One of you must become king when I die, so I will test you to choose which one". Then he took three feathers and said, "You must go the ways I throw the feathers and bring me the finest mat".

So the eldest son, Neville, went forth, the second went south, and the youngest son's feather landed on the floor near a trap door, so he went down through that. He found lots of toads at the bottom, and he asked the queen toad to help him. The queen asked the toads to find him the finest mat.

When the king asked his sons to bring the mats, the youngest son's mat was chosen as the best.

The next day the king said, "Bring me the finest rings". This time the eldest son went west, the second went south,
and the youngest son went through the trap door again. He asked the queen toad for the finest ring, and when the king saw the rings the youngest son won again.

The last time the youngest son went through the trap door, and asked for the beautiful princess. He married her and became King, and he is still the only one who knows about the secret trap door.

3.4.4 Book 4

Stories written independently of children.

The Weekend
One Saturday morning Joe went to call for Peter. It was early, about eight o'clock, and Peter's mum said, "He hasn't had his breakfast yet, come back later". Joe walked up and down the street, kicking a stone, until half past eight. Then he went back to Peter's house, and Peter was ready. Peter said, "What shall we do today?", and Joe said, "I know, let's go and knock for David and Martin". So they went to David's house first, and said, "Do you want to come out?" David said, "I can't, 'cos I have to go to my gran's today". "OK", said Peter and Joe, "see you Monday". Then they went to Martin's house, and asked him to come out. Martin said, "OK, what are we doing?" They decided to go to the park, to play football. When they got to the park it wasn't open because it was too early, so they played around in the street. The ball rolled into the road just as a car was coming along. Joe nearly ran after it but Martin said, "Stop". So they waited 'till the car had passed. Then the ball came back to the side of the road, and rolled under a car. Peter had to crawl under the car to get the ball, and he got his clothes dirty.

Then they saw the gates were open so they went into the park, and played some football, but it wasn't very good 'cos there
were only three of them. They went to the cafe and got some drinks, then went along the river. It was very hot so they decided to go in the water. They took off their shoes and socks and went in the water.

Suddenly Martin trod on a sharp stone and fell over in the water. Joe and Peter laughed, but Martin was cross because he was all wet. They got out of the river and went back to where they had left their shoes and socks. Joe couldn't find one of his shoes, but then they saw a big dog, and he had Joe's shoe in his mouth. They got the shoe back, but it was chewed and wet.

Then the three boys went home and their mothers gave them some clean, dry clothes to wear, and a big lunch after their adventures.

The Circus

One Friday, on the way to school, Christopher saw some large vans coming to the park. It looked like a circus. So when he got to school he told his friends, and they talked about the circus all day. After school they went to the park. They saw some men putting up the big tent, and lots of people rushing about, and some animals in cages. Then a big man came over and shouted at them, "Go away from here, you're getting in the way, and we have to get ready for the show tonight". The man looked very angry so the boys went home. Christopher asked him mum and dad if he could go to the circus, and they said, "Yes, we'll go tonight after tea".

So they went to the circus, and saw the clowns and the horses, and elephants, and the acrobats. The clowns were very good, they threw custard pies, and had fireworks in their trousers. The acrobats were very clever, they did all sorts of tricks on the trapeze, high up in the air.

After the show Christopher had a drink, and went round the back to see the animals resting in their cages. Then he went home. On Monday when he went to school, he told all his friends about the circus.
The Magic Ring

Once there was a girl called Jane, and she took her dog for a walk on the common. He went running off. "Come back Spot", she said, but he didn't. So she ran after him. Suddenly she was in a wood and she was lost. Then she saw an old woman who said, "What's the matter?" "I'm lost", said Jane and began to cry.

The old woman said, "If you come and help me with some jobs, I'll help you get home again".

Jane went with the old woman, and they came to a cave. "This is my place", said the old woman. She told Jane to sweep the floor, and tidy everything up. Jane cleaned the cave very well, and made some dinner. Then the old woman said, "You are a good girl, so I will help you now". She gave Jane a ring with a red stone in it, and told her it was a magic ring. So Jane wished that she could find her way back home, and then she found herself back on the common. Spot came running up to her, wagging his tail, and they both went home for their tea. When Jane told her mum what had happened, her mum didn't believe her, so Jane showed her the ring. They wished for lots of good things, and they all came true, so then Jane's mum did believe her.

Sam's Seeds

Sam walked slowly down the road, his hands in his pockets. He looked fed up because he was frowning. But actually he was thinking. He was thinking awfully hard about what he could get his mum for her birthday. It was rather hard because Sam was only little and he only had 10p pocket money every week. Usually he spent it on sweets after school so he only had this weeks 10p to get something for his mum, and even if he was only seven he knew 10p didn't buy much these days.

Anyway Sam went down the road to the corner shop - the one that stayed open late and had all sorts of things - apples
and chocolate and comics and cakes and shampoo, all mixed up together in the little shop. As Sam went in the bell on the door rang loudly and made him jump. The shop lady had on a flowery apron and had black curly hair and she smiled at Sam. "Hello love", she said, "Want some sweets do you?" "No", said Same, "today I want a present for my mum's birthday". Then the lady said, "Well, what do you want for your mum?" Then Sam started looking worried again, "I don't know", he said, "I've only got 10p, what can I get?"

The lady thought of lots of things like shampoo, or bath salts, or chocolate but Sam kept shaking his head. "It's not special enough", he said every time.

Then a man came in for a paper and while the lady served him Sam looked around. He saw a rack with lots of little packets on it. They had pictures on, mostly cabbages and onions and things, but then he saw one with a picture of flowers on. They looked ever so nice, all different colours. The lady saw him looking and said, "So you're looking at the seeds are you?" "Yes", said Sam, and then asked, "What's seeds?" The lady explained to him about planting seeds and them growing into vegetables or flowers. Sam asked if you could grow the flower ones in a window box. When the lady said yes, and told him they were only 8p Sam made up his mind. "That's what I'll get then", he said, and the lady wrapped the seeds nicely in a blue paper bag for him.

Next day when Sam gave the present to his mum she was very pleased and they planted them in the window box. Then they waited until one day some little green spikes came up and grew and grew and grew. Sam watched them until one day a flower came out and then another and another until there was a whole row of them, just like the picture on, the packet — only better. Sam's mum said, "That was a really good present Sam".
At last it was spring. After all the cold grey days of winter it was suddenly warmer, and the sun was shining.

Jim and his sister Sally, decided that they should go out and enjoy the sunshine, but they couldn't decide what to do. "Shall we ride our bikes?" asked Jim. "Oh, I'm bored with just riding up and down", said Sally, "I want to do something exciting". So they thought again. "I know" said Sally, "Let's go to the park". "All right", Jim said, "I tell you what, we can do some fishing there". Sally thought that was a good idea, so they started to look for their fishing nets. The trouble was they hadn't used them since last summer, and they couldn't remember where they were.

Their dad was in the garden cutting the grass, so Jim went out and asked him if he had seen their nets. "Have you looked in the shed?" asked his dad, "I think they might be there". Jim went into the shed and sure enough, there were the nets up on the shelf. He got the old stool and climbed up and got them down. They were very dusty so he blew the dust off. Then he ran up to the house calling, "Sally, Sally, I've found them". Sally said, "Oh, well done Jimmy". Then she had a bright idea. "Why don't we ask mummy if we can take our tea with us - then we could have a picnic". "Oh yes" said Jim, "That's a great idea. Come on, let's ask her now".

So they went into the kitchen and Sally said, "Mum, can we have a picnic in the park?" Mum said, "Well, I don't know if it's quite warm enough for that yet". "Oh please Mummy" Sally begged, and Jim said, "Oh go on Mum, be a sport". "Oh all right then" agreed Mum, "but you must take your raincoats to sit on because the grass will probably be wet". "OK" Jim and Sally said, "Thanks Mum".

Their mum made them some sandwiches, and gave them some cake and biscuits and two cans of Coke. Off they went to the park, Jim carrying the fishing nets and a jar for the fish, and Sally carrying the bag with the picnic in.
When they got to the park they started fishing in the stream. There were lots of little fish there, but they didn't want to be caught. At last Sally caught one little fish, then Jim caught a fat one, and Sally caught another little one. They put the three fish in the jam jar, with some water from the stream, and a piece of week for the fish to eat.

Then they decided it was time for tea as they felt very hungry, so they spread their raincoats on the grass beside the stream, and spread out the picnic. They ate all the sandwiches, the cake and the biscuits, and drank the Coke. By the time they had finished the sun had gone behind some big black clouds. Jim said, "It looks as if it's going to rain". "Yes" said Sally, "and it's getting cold now, too. I think we'd better go home".

They tipped the fish back into the stream, because they wouldn't live long if they took them home. Then they put on their raincoats, picked up the fishing nets, and started walking home.

They were very nearly home when a big raindrop landed on Sally's nose. Then Jim felt a drop on his head, and suddenly it was pouring down with rain. "Let's run" said Sally, and so they ran the rest of the way home. When they got there they were only a little bit wet.

"Did you have a good time?" asked their Dad. "Oh yes", said Jim and Sally, "and we caught three fish". Their mum said, "Did you enjoy your tea?" "Yes thanks Mum", they said, "Can we have another picnic next Saturday?"

"Well we'll have to see what the weather is like" said Mum.
The Hallowe'en Party

Jane is twelve years old and her brother Colin is eleven. Last October they wanted to have a Hallowe'en party, so they asked their parents if they could. Their parents said "Yes, I think you are old enough now". (In previous years they had thought that the children would have not too frightened.)

Jane and Colin began preparing for the party. First, they discussed how many friends they would invite, and decided that if they each asked four friends that would make the best number.

Colin telephoned his friends, John, Peter, James and Michael. Unfortunately Michael could not come, because he was going out with his uncle, but the other three said they would like to come. Then Colin invited Philip to make up his four friends.

Jane telephoned Diana, Maggie and Ann, and they all accepted the invitation. Sarah wasn't on the 'phone so Jane had to walk round to her house to ask her. Luckily she also said yes.

Jane and Colin had decided that it should be a Fancy Dress Party, so they told their friends to dress up as ghosts, or witches, or something like that.

Jane herself wanted to be a witch, and Colin thought he would be the witch's black cat. They asked their mother to help them to make the costumes. Jane would wear her long black skirt, and black jumper, with a cloak made from black crepe paper, and a tall hat made from stiff cardboard. Colin would wear his thick black jumper and black corduroy jeans, and furry mittens on his hands. They made him a cat mask with cardboard, with whiskers from straws.

They made lanterns by hollowing out some large turnips, cutting faces in them, and putting candles inside. Then
they hung some spooky rubber spiders and flies from the ceiling, and cut out shapes of witches and skeletons to stick on the walls.

Jane talked to her mother about what food they should have, and they decided to have hot-dogs, cheese dips with crisps, some sandwiches, little cakes made to look like witches hats, and lots of peanuts, twiglets, and chocolate biscuits. They would have Coke and orange to drink, with ice-cream in the Coke.

Colin discussed the games with his father, and they thought of such things as Bobbing for Apples, Hide and Seek in the dark garden, musical chairs, and so on. There would be little prizes for the winners, and for the best costume.

Colin and Jane waited impatiently for the evening of the party. At last it came. Everything was ready and at seven o'clock their guests started to arrive. John was dressed as a ghost in a big white sheet. Peter and Philip both came as skeletons, with white bones painted on the front of their old clothes. James was a wizard with a hat even taller than Jane's. Maggie was dressed as a goblin with curly horns and a long red tail. Diana and Ann were both cats, and Sarah was a witch.

They all went out into the dark garden, and pretended to be frightened. It was a good game, but suddenly Diana gave a really loud scream. She sounded really scared - not just playing. The others ran over to her and asked what was the matter. "Something ran across my feet", she cried, "It was something dark and scary". "But what was it?" asked Jane. "I don't know, but it was big and black and I'm frightened", said Diana. Now they were all a bit scared - because they had been pretending to be frightened, it was easy to get really frightened. They went running back towards the house shouting for Jane and Colin's parents.
Their father came out and said, "Calm down. What's the matter?" "There's something spooky in the garden" said Ann, and explained about Diana getting frightened, so he went into the garden to have a look around. A few minutes later he came back, with a fat black kitten in his arms. "Here's your ghost" he said. The children all crowded round and admired the kitten and completely forgot their fright.

Then they played some more games - indoors - and ate the supper. The guests went home at nine o'clock saying "Thank you for a lovely party" and "let's have another next year".

3.4.3 Comprehension Tests

The Weekend

1. Why couldn't Peter come out straight away when Joe went to call for him at eight o'clock?

2. Why couldn't David join Peter, Martin and Joe?

3. What did Martin say when Joe nearly ran after the ball on the road?

4. What did Peter do to get the ball?

5. Where did they go after they had their drink in the cafe?
The Picnic

1 Why couldn't Jim and Sally remember where their fishing nets were?

2 What was their dad doing when they asked him if he had seen their nets?

3 Where did Jim find the nets?

4 What bright idea did Sally have?

5 Why was mum not sure of this idea at first?
What did mum say they must take with them to sit on the wet grass?

What did they do with the three fish they caught?

Where was the sun by the time they had finished their tea?

What did they do with the fish before they went home?

Why did they start running on their way home?

Whose birthday was Sam thinking about?

How much pocket money did Sam get a week?

Name three things which the corner shop sold
1. 2. 3.

What did Sam get for his mother's birthday?

How much did Sam pay for the present?
1. The dog got wet and Tom had to rub him dry.
2. He was a very good boy to give you some of his sweets.
3. My sister likes me to open my book and read to her.
4. Go away and hide behind that door where we found you just now.
5. Please don't let anyone spoil these nice fresh flowers.
6. The string had eight knots in it which I had to untie.
7. Wine is made from the juice of grapes which grow in warm countries.
8. Mary went to the grocer's and bought some sugar and some syrup.
9. Quench your thirst by drinking a glass of our sparkling ginger ale.
10. The people could scarcely obtain enough food to remain healthy.
11. Elizabeth had her hair thoroughly combed and her fringe cut.
12. By stretching up, George just managed to touch the garage ceiling.
13. Father had a brief telephone conversation with my cousin, Philip.
14. This coupon entitles you to a specimen piece of our delicious toffee.
15. The chemist could not suggest a satisfactory remedy for my headache.
17. Leonard was engaged by the Irish Linen Association to act as their London agent.
18. Judged by his photographs your nephew is certainly a peculiar character.
19. The examiner was impatient when I hesitated over a difficult phrase in my reading.
20. Delicate individuals should gradually be accustomed to gentle physical exercise.
21 The musician whose violin was interfered with has our sincere sympathy.

22 The soloist was not in a convenient position for seeing everyone in his audience.

23 Christopher omitted to acknowledge the receipt of Michael's annual subscription.

24 The secretary said there had been a substantial increase in the Society's expenditure.

25 The Borough Council decided to celebrate the occasion by organising a gigantic sports festival.

26 It is essential that engineering apprentices should acquire some good technical qualification.

27 Particulars of the careers of eminent men will be found in any good encyclopedia or biographical dictionary.

28 Certificates of insurance will be issued to all policyholders paying the necessary premium.

29 The ceremony ended, appropriately enough, with the Choir and Orchestra joining in the National Anthem.

30 It is both a newspaper which chronicles events and a magazine with the usual miscellaneous features.

31 The necessity for accelerating the work of the Economic Conference was repeatedly emphasised.

32 These documents constitute an authoritative record of a unique colonial enterprise.

33 Psychology is a science which seems to fascinate both the adult and the adolescent student.
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4.1 Introduction

Many a Judge has to deliver judgements for one or other of the two parties in a legal tangle when he knows there is not a clear case one way or another. Benefit of the doubt rarely if ever can be applied in civil suits. For example, when a car starts to move at the traffic lights and suddenly stalls, the car behind can easily hit it. If there is a case for damages, the Judge cannot say "We are not sure whose fault it is so hard luck!" He has to make a judgement which is authoritarian even if it is that both the parties were at fault and must pay for their own damage.

A teacher is in a somewhat similar situation. When confronted with a class to teach a subject, he cannot take the position that he does not know the best or the right method of teaching so he better not try teaching this day. In short the teacher must decide on a teaching strategy, which he must pretend to be 'right', in spite of the uncertainties. He must however continue to explore fresh strategies and seek 'better' teaching methods. One day perhaps Judges will also realise that they too, who can never be wrong, must seek to improve their legal problem solving.

In the following few pages an operational definition of a system of teaching is defined and explained. It may seem authoritarian to the reader, but then all prescriptions do seem that way. However, that is not the objective of the chapter. Chapter 2 explored the possibilities of 'discovering' a learning method from observing people in their work-a-day situation. In Chapter 3 this method was applied to teach children to read with some success. In this chapter the postulates of the method of learning as applied in the teaching example given are translated into a method of teaching. After all the whole object of looking for a method of learning in the end is to use it for teaching.
In the subsequent development of the material for CA, this is utilised. A clear definition for it therefore is necessary. In the next chapter, the requirements arising out of this definition are brought together with the requirements arising out of the definition of CA, those arising out of practical considerations of organisation of the schools and the facilities available, and those arising out of some of the research findings of relevance to the present task. A final prescription for the course is therefore given then. For now a method of teaching. The postulates are given here again to save the reader thumbing through the pages.

The Postulates

(a) Human beings possess a cognitive map of reality in the form of functional units.

(b) Human perception of events has the following properties:

   (i) it is dynamic

   (ii) it is dependent on the event as well as on the existing cognitive map

   (iii) it comes in functional units.

(c) If the cognitive map relates, but only imperfectly, to the perception of an event then a motivation exists to render the relationship perfect.

(d) Learning takes place if

   (i) the imperfection cannot be removed without co-opting a new functional unit into the existing cognitive map

   (ii) the total effort required to learn and to remove the imperfection is commensurate with the motivation generated.

It may be noted from the postulates that the emphasis is on the needs of the learner. Any educational activity based on these postulates will utilise the inherent potential of the learners to acquire the new functional units. In the method of learning defined below it might seem, at first sight, that the entire activity is designed to pamper the learner rather than to meet educational objectives. This in fact is not the case as will become apparent during the discussion following the definition. The reader should therefore beware of the temptation to
write off this method as 'progressive' or 'ineffective' or 'soft'. The educational material (Part II) based on this method goes through the full rigours of educational process.

4.2 Operational Definition of a System of Teaching

A formal definition of the procedure for teaching is given as a whole first. Each element is then discussed to clarify its meaning.

4.2.1

The system of learning is so organised that

1. The initial activity is largely within the existing cognitive map of functional units of the learner.
2. At the start, and subsequently, it is perceived by the learner as a whole in which properties of each part are related to other parts and to the whole.
3. It is dynamic in which each event that takes place is perceived by the learner to be related to the previous events and is expected to be related to the events which may follow.
4. That the learners perceive an imperfection in the relationship between his cognitive map and the perception of the system at the start or soon after.
5. The action required to remove the imperfection as perceived by the learner will result in the acquisition of functional units, as envisaged by the designer of the system.
6. The effort required to learn is commensurate with the learner's motivation to remove the imperfection, i.e. the learner succeeds in removing the imperfection before he exhausts his motivation.
7. Every time that the learner renders the relationship perfect he is offered a fresh imperfection until the learning goal, as envisaged by the designer, is achieved.
8. At all times during the sequence the system (which is being modified as events take place), remains within the cognitive map of the learner, intended imperfection excepted.
4.2.2 Explanations

(1) Initial activity can be organised to be within the cognitive map of the learner if the following points are borne in mind:

(i) In conventional teaching, a logical structure of 'knowledge' is built starting with the existing knowledge base of the learner. If it is understood that the base for starting an activity is a set of functional units instead of 'knowledge' then half the battle is over. Thus, for example, a child may be able to recite 'times table' with facility, but not 'use' them from memory in actual sums. Unless he can abstract the relevant information from a problem and relate it to the 'times table' he has not got what is defined as 'functional unit' for this purpose. The functional units he has got are to recite the tables or abstract information from them for straight multiplication. The first activity therefore will assume only these units and will therefore start at developing the skill to use them in real sums.

(ii) In practice, of course, it does not take long to determine the existing cognitive map of the learner. In the experiment described in Chapter 3 this map was quite quickly determined by asking the children to narrate stories of their own. If this method is employed on a regular basis then, of course, the teacher should be aware of this cognitive map in any case. When using this method for the first time a preliminary 'chat' with the learner and an initial 'discovery' activity can be usefully employed to determine the starting point. So long as the learner is able to related to the starting activity there need be no further anxiety on the part of the teacher on this count.

(iii) As in most cases it is a group of learners that educationalists are generally concerned with rather than with individuals and it is the collective cognitive map of the group which needs to be defined. However, just as it is assumed that it is possible to define a 'collective knowledge base' of a group of learners, it can be assumed that there exists a 'collective repertoire of functional units' of a group with slight variations from one individual to another. In fact, as is indicated in (i), existence
of knowledge implies existence of a set of functional units only at a lower level or at least at different levels.

(iv) There is no need for an exhaustive diagnostic procedure for determining the repertoire of the functional units for a group. As was indicated elsewhere the implementation of this method is more of an art than a science. With little practice it is not difficult to initiate an activity which 'gets them going'.

(2) and (3) Elements of any human activity has two dimensional relationships: one lateral and one temporal. As in a cinematograph film, each element within a frame is related to every other element, and each frame is related to the previous frames and those which follow, human cognitive activity is constituted of a set of events related in the two dimensions. All the related events form a whole. When an educational activity is offered in bits then the learner will try and make up his own whole form within his cognitive map, which may or may not be the same whole which the designer of the activity had envisaged. It is therefore desirable that the activity offered should include sufficient information, some of which may not be necessarily a part of the 'objectives', to allow it to be perceived as a whole. Further, the bits offered, although logically related, may not be perceived by a learner as to be temporally related, i.e. not following each other 'naturally'. For him to 'store' an unrelated 'bit' for retrieval later will be difficult. The art of successful course writing depends upon presenting an activity which is continuous (after the fashion of cinematograph film) laterally and in time. Once again it may be seen that learning to read by reading stories is more desirable than reading a set of unrelated words. Similarly a game of football is more complete and hence more easily accepted actively than sprinting for example, unless of course sprinting forms a part of something else such as entering for an event on the sports day.

(4) and (5) Much has already been said (pages 43-46) about perception of an imperfection in a relationship between an event and the cognitive map. However two points should be remembered on this count. First that an imperfection is introduced to motivate the learner to act and second that the action undertaken by the learner should result in the desired learning. As in the example given on page 47 of a picture of a giraffe with 'incomplete' neck, the motivation to 'complete' the neck should be
utilised to get the learner to learn what the designer wished him to. Thus if it is felt desirable that the learner should develop a facility to draw freehand then an incomplete picture and a pencil should be provided.

An imperfection may be introduced by presenting information which is incomplete or one in which all the elements do not quite fit together or by just making a statement which raises doubts and uncertainties.
## PART II

The Implementation

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5.1 Introduction

The general approach to computer education for all as well as to a suitable method of teaching was discussed in Part I. The principles developed have to be translated into a set of clearly defined requirements for a course for CA. Apart from these requirements there are some which must be met whatever the course. In addition there are the requirements which arise out of the way schools are organised. Further, there are some research findings which are of interest to the course envisaged. All the requirements are brought together in this chapter as follows:

(a) General Requirements (section 5.3)

(b) Requirements Specific to CA (section 5.4)

(c) Requirements Specific to Self-Learning Packages and Packages using Interactive Computer Terminals (section 5.5)

Towards the end of the chapter in section 5.7 a complete list is given of all the requirements to facilitate their implementation during the development of the educational course. This is repeated in the Appendix to enable the reader to refer to it more easily while he is reading the account of the development of their modules given in the rest of the chapters in this part.

5.2 Organisation of the Procedures for the development of the Material

A Working Party of teachers with the author as Chairman was set up in 1972 to aid in the development of educational material suitable for Computer Awareness.

Members represented the following institutions:
(i) Charterhouse, Godalming, Surrey
   Independent, 13-18 years, 700 boys

(ii) France Hill School, Camberley, Surrey
   Comprehensive, 12-18 years, mixed 1300 pupils

(iii) George Abbot School, Guildford, Surrey
   Bilateral Secondary, 11-18 years, mixed 6th form 950 pupils

(iv) Gipsy Hill College of Education, Kingston
    Infant and junior school student teachers, 800 student teachers

(v) Godalming College, Godalming, Surrey
    Grammar until 1974, mixed 600 pupils
    Mixed open access 6th form college since September 1974, 870 pupils

(vi) Goodwyn's Middle School, Dorking, Surrey
    8-12 years mixed, 350 pupils, joined in 1973

(vii) Mowbray School for Girls, Dorking, Surrey
    12-18 years girls, 350 pupils, joined in 1973

(viii) Rodborough School, Godalming, Surrey
      Mixed 12-16 years, Comprehensive Secondary, 960 pupils, joined in 1974

(ix) Sondes Place School, Dorking, Surrey
     Bilateral Secondary, 12-18 years boys, 600 pupils, joined in 1973

The brief of the Working Party, relevant to the work described in this dissertation, was:

(a) To advise on the structure of the educational material
(b) To run trials for any educational material produced
(c) To evaluate the educational material.

Periodic meetings were held to discuss the issues involved and resolve any practical problems that arose from time to time. Whereas the help given by the members of the Working Party was invaluable their contribution to the development of the material was limited to advising on the drafts and implementing the field trials. The author was responsible entirely for the philosophy of the educational material and
its actual development. The members of the Working Party also helped to bring to the notice of the author the realities of the education world when the author indulged in more fanciful flights of imagination.

5.3 General Requirements

Due to the shortage of teaching expertise for computer education at the time (1972-1975) it was decided that the material produced should assume little or no knowledge on the part of the teacher, and further that the material should be self-learning as far as possible requiring little or no allocation on the timetable of schools. With the pressures on curriculum being heavy it was felt that most schools would be reluctant to spare actual teaching time for a subject which was not primarily designed for examination.

As should be obvious from what has been said in earlier chapters that direct experience of computers is desirable as far as possible to create situations in which people acquire general awareness. A decision was therefore made that the material produced should utilise interactive computer terminals connected to the University ICL 1900 computer, which were already in existence in a number of schools listed above.

Informal discussions were held with the Headmistress of Mowbray School and the Headmaster of Sondes Place School, both in Dorking, to determine their attitude towards implementing a scheme for teaching CA. They were both quite happy to allow children to take time off from various lessons to use self-learning material, provided this did not happen too often. Based on this and further discussions with the teachers it was obvious that total time requirement for a course of study should not exceed ten hours, children taking time off from five or six double periods (one period = 35-40 minutes) from other lessons, with time to spare if required. All the institutions involved agreed that either a separate small room would be provided to house the computer terminal or that if a classroom was used then there would be time available to use it for the purposes of this activity exclusively.

It was therefore decided that, in the first instance, a set of modules of 'kits' as they were called be produced which the children could use
on the computer terminal by themselves with minimal supervision, and
each module lasting no more than one hour total time including
preparation and winding up. If this procedure caused any excessive
difficulties then it was understood that some other procedure would be
sought. In the event it turned out that whereas the kits had to undergo
several modifications this method was found adequate. No other procedure
therefore was developed. Most of the schools organised the supervision
by the sixth formers, thus reducing the demand on the time of the teacher
in charge still further.

3.4 Requirement Specific to CA

That CA can be developed only by experiencing computer applications is
implied in Part I. This is how, it was contended, people acquire any
awareness. The main difference between an educational material for
acquiring an awareness and the situations which arise naturally in life
is that educational material can at best simulate real life situations.
Real computer applications, however, vary considerably starting with
using the computer as a 'printing press' to simulating human intelligence.
Computers are used for intricate scientific analysis, for example, in
astronomy, for 'online' monitoring of patients in intensive care units
in hospitals, for machine tool control and of course in commercial data
processing and so forth. Computer Awareness is understood to be the
possession of general principles of computer as well as experience of
computer applications, as was described in 1.4.6 on pages 23 and 24.
As far as the development of general principles is concerned any of the
computer applications would have done provided that they were found
efficacious. But any experience of computer applications as part of CA
has to be very carefully designed so that the applications chosen are
ones the learners are most likely to meet in real life, and that the
more exotic applications were better left out if the time available
allows for dealing with only a few of them. This was borne in mind when
deciding the final list of computer applications for the kits.

One of the causes of lack of existence of CA in populace as a whole was
allocated to the fact that the visual and conceptual image of computers
around which awareness may be developed is missing (see page 15).
Before anyone can start developing CA by experiencing simulated computer
applications it is necessary for him to acquire this image. This image is not simple as it does not only relate to what computers look life but also what function they perform. It is similar to most peoples image of a motor car, i.e. it travels from one place to another in addition to what it looks like. Since the visual image of a computer as a grey or blue box does not convey its function by just looking at it, a special procedure needs to be developed to convey what can be called visual and conceptual image of the computer. This is even more important if CA is being developed using computer terminals as it is not difficult to think of the terminal as 'the computer'. The sole aim of such a procedure would be to enable learners to have a conceptual nucleus to relate to whenever they see or hear something about computers.

5.5 Requirements Specific to Self-Learning Packages and Packages using Interactive Computer Terminals

In addition to the requirements of the "Operational Definition of a System of Teaching" described in Chapter 4, there are some requirements which apply specifically to Self-Learning Packages.

Clearly it is even more important for self-learning situations that the existing repertoire of functional units of the learners is accurately 'guessed' as the learners will not have an opportunity to 'ask the teacher' as would be the case in classroom situations.

Likewise all the facilities, which the learners need to go through the packages not already possessed by them and are not required to develop as part of the learning task, must be provided. For example, if learning to write a computer program is not one of the objectives of the material a program is used for learning something else, then it must be provided. It is a great temptation for writers of educational computer packages to use the terminal to produce masses of text for instruction, information and so forth. Apart from the fact that this procedure can take longer than providing the learner with ready text, learners also find it difficult to read the text produced on the terminal and certainly cannot assimilate the information, as it is being printed. Further, since 'the computer' is the 'subject' of study, use of the computer to instruct or do anything outside the application under study only causes confusion. The structure of the material developed therefore avoids use of the machine for anything except as an object of study.
There are not many research findings in the field of self-learning packages which can be adopted for the present needs as most of the research carried out utilised S-R model of learning. However, there are some significant results which could be 'transferred' in the development of self-learning packages for CA. More obvious ones are given here.

(a) Slater E. Newman (1961)
"Our analysis suggests that when two or more pairs comprise the list, it will be learnt fastest if the (mediating) response to each stimulus term meets the following requirements:
1. It takes little time to give - the less the better
2. It takes little energy to give - the less the better."

(b) James G. Holland and Douglas Porter (1961)
"... the present results indicate that retention is greatest when the program produces a low standard error rate."

(c) Portman, Leo, and Sanders, Virginia L (1946)
"When there are several types of material that can be learnt, specific instructions to learn a given category will improve retention for that category."

(d) Rothkopf, Ernst Z. and Esther U. (1964)
"Zero repetition interval was appreciably less effective than randomly determined interval."

The way each of these conclusions is interpreted for and incorporated in the kits is discussed in the description of each kit.

One major problem, which emerged in the early stages of the development, concerns the initial use of a computer terminal by children. Most children are hesitant to use the terminal because it seems they are afraid of it. There is therefore a need to produce a module with a specific aim to overcome this fear. This module can also be used to gain familiarity with the terminal thus separating what children have to learn to use the machine successfully, and what they have to learn to acquire CA.
A major assumption was made that all or most of the children in the schools possessed little or no CA. This assumption was not based on any formal evaluation, rather on the general consensus of opinion prevalent at the time (in 1972). This should be obvious from what was said in "The State of the Art" in Chapter 1. This was also the opinion of the members of the Working Party of Teachers mentioned in section 5.1 of this chapter. Having assumed that 'pre-knowledge' regarding computers, as far as CA is concerned, is the same (i.e. nil) in the whole ranges of age and ability, it was felt that a lot of effort and time would be saved if only one set of instruction modules suitable for the whole school population could be developed. This kind of educational exercise, to the best of the author's knowledge, had not been tried before. Cautiously this decision was taken. Careful observation of the learner's responses during informal and formative stages of the development of the material showed that this approach had possibilities. One problem, insoluble on the face of it, was regarding children who had reading difficulties. This problem, however, was solved by pairing children when they actually sat at the terminal to work together, operating the keyboard in turns and making sure that at least one of the pair could read the instructions. Pairing of children was found desirable on other counts as well. First it cut the actual connect time to nearly half. Then the need to seek help from the supervisor was reduced to insignificance. It was also found possible to maintain a standard of language in the material which was within the grasp of younger children, yet did not offend more mature pupils. The target population for this exercise was therefore: 11-18 years, all abilities and both sexes.

5.7 Summary of Requirements for the whole set of Modules

In this section a summary of all the requirements which apply to the total course are given. These include the requirements arising out of the method of teaching and learning as described in Chapters 2 and 4, and the general requirements and those specific to CA and self-learning modules using interactive facilities as discussed earlier in this chapter. This summary is given here to enable the reader to refer to when various points arise during the description of the material in the
following pages. The requirements specific to each module are discussed in the description of the material. References to pages of this dissertation where the requirement was originally discussed are given in brackets following each set of requirements.

(A) **Target Population**  (page 117)

- Age ranges: 11-18 years
- Ability ranges: All
- Sex: Both

(B) **General Requirements**  (page 113)

(i) Minimum teacher expertise and time requirements.
(ii) Self-learning modules.
(iii) Direct experience of computers via interactive computer terminals.
(iv) Maximum time for the whole course: 10 hours
(v) Maximum time for each module: 1 hour

(C) **CA Requirements**  (page 114)

Should include

(i) Experience of common applications of computer systems.
(ii) Experience of computer properties relevant to CA.
(iii) Development of visual and conceptual image of computers.

(D) **Requirements arising out of use of self-learning packages on interactive computer terminals**  (page 115)

(i) Computer should not be used for instruction.
(ii) The learning instructions to be provided in the form of a booklet.
(iii) The actual typing by the learners to be kept to a minimum.
(iv) The effort required to use the material in activities other than learning itself (e.g. in perpetually referring to information on other pages) is kept to a minimum.
(v) Learners make no errors or only a small number of errors.
(vi) Statements regarding what should be learnt are made where appropriate.
(vii) Learning events are repeated, if required, at irregular intervals and never with zero delay.
(viii) A special module to be developed to introduce learners to the computer terminal.

(E) Requirements of the Method of Learning (page 105)

(i) The initial activity is largely within the existing cognitive map of functional units of the learner.
(ii) At the start, and subsequently, it is perceived by the learner as a whole in which properties of each part are related to other parts and to the whole.
(iii) It is dynamic in which each event that takes place is perceived by the learner to be related to the previous events and is expected to be related to the events which may follow.
(iv) That the learners perceive an imperfection in the relationship between his cognitive map and the perception of the system at the start or soon after.
(v) The action required to remove the imperfection as perceived by the learner will result in the acquisition of functional units, as envisaged by the designer of the system.
(vi) The effort required to learn is commensurate with the learner's motivation to remove the imperfection, i.e. the learner succeeds in removing the imperfection before he exhausts his motivation.
(vii) Every time that the learner renders the relationship perfect he is offered a fresh imperfection until the learning goal, as envisaged by the designer, is achieved.
(viii) At all times during the sequence the system (which is being modified as events take place), remains within the cognitive map of the learner, intended imperfection excepted.
6.1 INTRODUCTION

6.2 THE ORGANISATION OF THE COURSE
6.1 Introduction

Before discussing the actual development of the educational module a brief account is given in this chapter as to how the whole course was organised.

6.2 The Organisation of the Course

Based on what was said in Chapter 5, four broad but distinct aims for the modules emerge:

(i) A module to provide visual and conceptual image of the computer so that the learners can relate to what follows in the course;

(ii) A module to serve as an introduction to the computer terminal to enable the learners to acquire the skills necessary to use the kits and to overcome any fear they might have of computers;

(iii) Modules to give experience of computer applications in as realistic a fashion as possible; and

(iv) Modules to give experience of properties of computer systems relevant to CA.

The main objectives of the course are to be met by the modules in (iii) and (iv). Modules in (i) and (ii) only prepare the learners to accept the main modules. Further, the same modules meet the aims for (iii) and (iv). It is not only difficult to develop modules to give experience of application and to give experience of computer properties separately, but it is also against the general principle of learning established earlier to do so. The same set of modules are therefore required to meet the aims for (iii) and (iv).

Bearing this in mind three types of modules were developed and categorised as Type A, Type B and Type C. One module, Type A, was developed to
provide visual and conceptual image of computers. Another module, Type B, was developed to serve as an introduction to the computer terminal. Four modules, Type C, were developed to give experience of computer application and properties. This scheme is shown in Figure 3.

![Diagram of module types]

**Figure 3**
Types of modules required to impart CA to children using self-learning procedure on interactive computer terminals

The first versions of the modules were developed more or less in parallel, but as the revision was carried out the requirements for module Type B (Introduction to the Computer Terminal) was decided only after all the modules in Type C were completed. As a final exercise all the three types of the modules were looked at altogether and some minor changes made to match them to each other as far as possible so that they all formed an organic whole.

Specific objectives are given with the account of the development of each module in Chapters 7 to 10. Chapter 7 describes the development of module Type A. This is followed by the general description of
module Type C in Chapter 8. One module in Type C (Computer as an Aid to Planning Committees) is described in fullest possible detail to enable the reader to determine for himself how the multitude of requirements listed in Chapter 5 were actually met in practice. From the description of module Type C emerge the final requirements for the module Type B (Introductory), which is discussed in Chapter 10.

The reader may like to take out the copies of the modules and the list of the requirements before reading Chapters 7 to 10.
## CHAPTER 7

**EDUCATIONAL MODULE TYPE A**

**VISUAL AND CONCEPTUAL IMAGE OF THE COMPUTER**

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EDUCATIONAL MODULE 1
VISUAL AND CONCEPTUAL IMAGE OF THE COMPUTER

7.1 Target Population

Children in the contributing schools, all age ranges, all abilities, both sexes.

Objective

Children will develop a visual and conceptual image of common computers, which will enable them to accept information relevant to CA.

Pre-Conceptions

1 None, or

2 Some idea of what a computer may look like and how it is organised, or

3 An inaccurate image of computers.

7.2 Development of the Concept

During initial and informal discussions with children, it was obvious that some children had no way of relating any information they received, either from the mass media or socially, about computers to their cognitive map. It was diagnosed that they did not have a visual image which provided the function of the computer. They had no address to send the information to, to use the computer jargon. This had the result that they were unable to accept otherwise common information about computers. This problem was detected some half-way through the development of the whole material of the course. Some kits were in existence, though not in their final form, and children were already trying them.

A small group of visiting children (14+ years) were invited to go into the computer room of the University to look at what they liked and ask the operating staff and the author any questions they wished. The visit to the computer room was followed by a discussion. This procedure was
repeated twice again. The main information offered by those attending tended to be regarding the structure of the machine: such as the disc units, tape decks, memory stores and how the machine was operated, i.e. where the cards were read and where the output was printed, etc. Although they could not articulate exactly where the problem lay, children were obviously dissatisfied with what they had been able to find out about the machine. Towards the third meeting the dissatisfaction turned to frustration because they were unable to acquire meaningful information especially in this ideal situation in which they had the initiative to ask what they liked. However, in the final discussion session, when children were told to verbalise their sentiments without any regard to the feelings of the supervisors, they started making remarks which brought out the main cause of their frustration. What seemed like a chance remark by one of them, "What the hell does it do?", immediately turned the discussion on to the function of each unit of the machine in relation to the total function of the whole system. It took only minutes to give them the answers to their questions which seemed to satisfy them as they already had the basic information gathered during the previous sessions.

It was decided to try and portray the machine in the functional context and try out the idea on more groups of visiting children. The summer term of 1973 brought in many requests for visits to the computer room from schools. Before they actually looked at the machine they were given an introductory talk lasting some 20-30 minutes. This opportunity was utilised to develop the new idea.

Initially a block diagram (similar to Figure 4) was used to bring out the functional structure of the computer, followed by the photographs of each unit. During the trials with various groups of children two more problems emerged. The first was that whereas most children were prepared to accept that computers processed information, they constantly tried to relate the function of each unit to their previous experience
of other machines such as motor cars, food-mixers, etc. Unfortunately these other machines deal with more tangible products, i.e. with travel or with food, which are directly experienced. Comparison with mechanical adding machines only confused them further. The second problem arose because of the difficulty in conceptualising the idea of an information store and three speeds of store at that!

The first problem can be understood in the light of the "Operational Definition of a System of Teaching". The initial activity clearly was not within the cognitive map of functional units of the learners, although the second condition that the learner perceives the whole in which properties of part are related, is partially met. To this end an attempt was made to start with a description of some kind of an automatic process which has all or most of the ingredients, in principle, of automatic information processing. If this was achieved successfully then the transfer of image from one process to another might be easy or so it was thought.

The first candidate for demonstration was automatic cake factory and the second an automatic chocolate factory. When tried, however, food being too personal to children, the principles of automatic processing were completely drowned in the recipes of various foods under considerations and how mum's could bake better cakes than those by automatic factories. So much for this idea.
It is obvious that the example has to be within the immediate environment, but one which did not generate too much functional fixation which conflicted with the concept of computers. After a few trials the idea of an automatic shoe factory emerged. It was sufficiently immediate to all children in that its products were what they used every day; whose structure they knew, i.e. the soles, the uppers, etc; they even knew something of the process of putting it together, at least in principle. For example, when they split a shoe and tried to mend it themselves or had it mended. Yet they did not know too much about manufacturing details to cause any problems. The process had all the elements required to demonstrate the automatic information processing.

The second problem, the one regarding stores, was solved by describing in detail the storing operations during the manufacture of shoes - to make the point that the expressions 'fast', 'medium speed' and 'slow' applied to the storing and retrieval operations rather than to the stores. Further, it was explained the slow store was like a tape recorder, the medium speed store similar to a gramophone record and the fast store was made up of magnetic cores, and that the information existed in the form of magnetic signals thus rendering the idea of information storage in this context more tangible.

In general, the information provided in various slides was kept at the same level in the function hierarchy (see page 107 for explanation of this expression) as the level of information they might already possess about various other machines, with the exception of description of the stores for reasons already explained in the preceding paragraphs. Even then the excursion into the 'inner workings' of the stores was restricted to the shoe factory and lasted only six frames out of 48. In any case the information given in these frames related to, at all times, and led up to the information in the frames that followed. Apart from this and other details given from time to time, the lateral relationship (as explained on page 107) was maintained throughout the sequence.

The programme up to this stage provided the conceptual image of the computer at par with for example, 'a motor car has an engine to supply power, a steering wheel with which to steer, etc., and it carries people'. The later part of the sequence was devised to provide the
visual image for each of the units of a computer. Whereas it might be true that a person may develop a visual image of a motor car before developing a conceptual one under certain circumstances; in practice, however, both are developed simultaneously. As already explained earlier (on page 15) this is not possible with computers as their visual import does not convey their function. It was therefore necessary to establish the concept of a computer before the visual image. This did not, however, cause problems as this concept was developed from another, that of the shoe factory, which, it was assumed, children accepted.

The visual part had to be related to the conceptual part as each is a facet of the same entity. This was done by explaining each picture in the terms already used in the conceptual part, i.e. for example, instead of saying 'tape decks' the expression 'the magnetic tape decks, that is the slow store' was used.

7.2.1 Organisation of the slides

Four critical stages were identified in determining the sequence of frames. First, obviously, a frame to present the concept of an Automatic Shoe Factory from within the existing cognitive map of the learners. The second stage was the concept of the Shoe Factory which could be directly related to the concept of an Automatic Information Factory, but did not include the details of the stores; with intermediate frames between the first and second stages. The third stage was the concept of the Shoe Factory with details of the stores which was directly transferable to the equivalent concept of the Automatic Information Factory, with intermediate frames between the stages two and three. The fourth stage was the visual image of the various hardware components of a computer with intermediate frames. The whole sequence is given in the next section. Figure 5 depicts the concepts for the four stages.

The role of the intermediate slide was to 'bridge the gap' between the initial concept and the terminal concept in accordance with the principles of the advocated method of teaching.
FOUR CRITICAL STAGES OF THE LEARNING SEQUENCE

STAGE 1
Concept of the Automatic Shoe Factory which relates directly to the existing cognitive map of the children

Intermediate frames

STAGE 2
Concept of the Automatic Shoe Factory which is directly transferable to the concept of the Automatic Information Factory (without the details of the stores)

Intermediate frames

STAGE 3
Concept of the Automatic Shoe Factory which includes the details of the various stores, transferable directly to the equivalent concept of the computer

Concept of the computer which includes the details of the three speed stores

Intermediate frames

STAGE 4
Visual image of the various hardware components of a computer system, each one relating to the equivalent components of the concept

Figure 5

130
Since subsequent modules of the course on CA utilise interactive computer terminals, two frames were specially developed to deal with them. The point had to be made that the interactive computer terminal was an input and output unit in one. Mention was also made of the main advantages and disadvantages of the device.

7.3 Development of the Material

7.3.1 Alternatives Considered

After several trials with groups of children, and of teachers, using diagrams on the blackboard for the first part and projected pictures on a screen for the second, an investigation was made into various modes of presentation to discover the best one. In principle these were the possibilities:

(i) A teachers guide which informed a prospective teacher of CA about the approach, and how to best present the information to children on a blackboard. Colour slides for the actual units could be provided.

(ii) A set of colour diagrams on charts, say of size 30" by 20", for both parts, or charts for the first part and colour slides for the second. The teacher would talk through the material.

(iii) A set of slides for the whole sequence with the teacher giving the commentary.

(iv) A set of slides for the sequence with running commentary on a sound tape with audio clues for manual change, or with synchronised automatic change of slides.

(v) A colour or monochrome film with dynamic frames for the first part and machines in actual use for the second.

(vi) A video tape to the same effect as (v).

7.3.2 Remarks

(i) depended on the teachers own knowledge and in spite of the guide the teacher would have to prepare before he conducted the lesson. As one of the requirements (B(i) in Summary of Requirements on page 117) was that the material should require minimum teacher time and expertise, this alternative was not considered ideal.
(ii) had the same disadvantage as the first. In addition it was discovered that to produce large charts in colour costed a lot more than colour slides, and changing the slides was easier than changing the charts.

(iii) had the same disadvantage as (i), if the teacher designed his own commentary. In principle acceptable if the teacher was provided with a commentary.

(iv) was considered better than (iii) as it relieved the teacher of interrupting his commentary to change the slides and constantly having to keep track of the events. Further, this approach allowed placing of the source of sound (and speaker) away from the projector for the best effect. The sound cassette added only marginally to the total cost of the production.

(v) Film is ideal in principle in that it allows dynamic representation of events. It meets the condition 3 of the Operational Definition of a System of Teaching (page 105) admirably, much better than alternative (iv) as it has dynamic flow of events visually as well as in sound. However the cost of production for a film is prohibitive. The unexposed film is expensive; the artwork is required for many hundred frames of the film, rather than only for 30 frames as it turned out for a set of slides. Consequently the unit cost for sale to schools is very high. In any case funds were not available to indulge in the production of the film. In fact, due to the cost considerations, this alternative was not investigated to any length.

(vi) The cost of producing a video tape was slightly less but still outside the limits of this work. This procedure had an added disadvantage in that many schools do not have video tape recorders to play back the production.

Taking everything into account it was decided to develop a tape/slide production.

Initially the sequence was developed with the help of the members of the Audio Visual Aids Unit of the University to whom the author owes much in this respect. The final production was developed by Diana Wyllie Ltd., a
commercial publisher of tape/slide productions. The whole of the
sequence, except the title frames, is given in the following pages.
The reader should bear in mind that projected slides with running
commentary has different import on the audience than the sequence as
portrayed on paper. Commentary as it appears on the sound tape is
given under each photograph. Comments for frames are given in the
form of notes at the bottom of each page.

In the final production the author was responsible for overseeing the
production of the artwork, the photographs, the recording of the
commentary and the layout of the booklet.

7.4 The Production

7.4.1 Production Details

<table>
<thead>
<tr>
<th>Publishers Title</th>
<th>Computer Awareness: An Introduction for All</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Production</td>
<td>A set of slides or a film loop, running commentary on a cassette and a booklet.</td>
</tr>
<tr>
<td>Frames</td>
<td>Full frames, 48 in all, 31 of artwork, 17 photographs of actual units plus titles.</td>
</tr>
<tr>
<td>Sound Tape</td>
<td>Total running time of 20 minutes, synchronised as well as audio signals for manual change of slides.</td>
</tr>
<tr>
<td>The Booklet</td>
<td>Giving reproduction of slides in half-tone monochrome and printed commentary.</td>
</tr>
<tr>
<td>Track Configuration</td>
<td>Compatible with USPECT 2.</td>
</tr>
<tr>
<td>Artwork</td>
<td>by Mary E. Ince</td>
</tr>
<tr>
<td>Photographs</td>
<td>by Brian Meech</td>
</tr>
<tr>
<td>Commentary</td>
<td>read by Barri Hainz</td>
</tr>
</tbody>
</table>
A copy of the actual production is included in the Appendix. The reader may like to actually use the material on a projector and a tape recorder to get the flavour of the production. Following is the account of the way various slides and commentary fit into the sequencing as a whole. This should be read in conjunction with the booklet which accompanies the production and a loose copy of Figure 5 also to be found in the Appendix.

STAGE 1: Slide 1 is aimed at meeting the requirements for Stage 1 as given in Figure 5 i.e. it gives the concept of an Automatic Shoe Factory as the reader would think it is. The concept of full automation is introduced in the commentary as "It is merely necessary to deliver the raw materials ... and to take away the finished shoes". It is not intended to present this concept as reality as at the start of the commentary for this slide it is said that "Let us pretend that there exists a fully automated factory", so that the learners appreciate that all these comments are given to help them to form an image of the computer later on.

STAGE 2: The slides 2 to 7 are designed solely to transform, in easy steps the learners' image of the automatic shoe factory to the one which can be directly transferred to an image of an automatic information factory. Slide 8 gives this image of the shoe factory and slide 9 of the information factory. The correspondence between the two is obvious.

STAGE 3: Slides 18 to 27 are aimed at transforming the present concept of the shoe factory to the factory having fast, slow and medium speed store so that it can then be transferred to the
information factory. Slide 24 gives this concept for the shoe factory and slide 25 for the information factory. Once again the correspondence between these two slides and commentary can be seen to be good. Slide 26 gives further details of these stores to complete the image of the three types of stores of a computer system.

STAGE 4: Slides 27 to 30 then pave the way to give actual pictures of the computing machinery in the context of the whole system. Slides 31 to 45 then are the actual picture of the various machines which may be seen to be a typical computer room. Once again each machine is related back to concepts developed for each of the components in slide 26. The only exceptions is the teletype as an input and output device in one - and this concept is graphically represented on slides 43 and 44.
CHAPTER 8

EDUCATION MODULES TYPE C (GENERAL DESCRIPTION)
(Numbers 3, 4, 5, 6)
EXPERIENCE OF COMPUTER APPLICATIONS AND COMPUTER
PROPERTIES RELEVANT TO COMPUTER AWARENESS

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8.3 SOME SPECIAL FEATURES 145
CHAPTER 8

EDUCATION MODULES TYPE C (GENERAL DESCRIPTION)
(Numbers 3, 4, 5, 6)
EXPERIENCE OF COMPUTER APPLICATIONS AND COMPUTER
PROPERTIES RELEVANT TO COMPUTER AWARENESS

The main modules to impart CA are described first, though the learners will do the kit "Introduction to the Computer Terminal" before the rest of the kits. This procedure is adopted as one of the objectives of the introductory kit is 'Children will develop skills to carry out the work prescribed in Modules Type C'. This can only be determined after these modules are developed.

Objectives

1. Learners will experience a number of computer applications.

2. Learners will experience properties of computer systems relevant to CA.

Pre-experience

1. Gone through the tape/slide (Module 1).

2. Carried out the work prescribed in the kit "Introduction to the Computer Terminal" (Module 2).

8.1 Development of the Concept of the Set of Modules

Much has already been said about requirements for these modules in the earlier pages of this dissertation. Development of the modules based on those considerations can be discussed in two parts: first regarding the concept and then the actual material.

It was obvious from the start that to get the children to write their own programs to experience computer applications was not the correct approach on the following grounds:

(i) The expertise required to write the computer programs for an application included computer awareness, at least partially. It includes the knowledge of the application area, problem solving skills, and an understanding of the machine. It seems that CA should form the
basis for children to develop computer programs rather than the other way round.

(ii) Computer programming required at the standard comes after a certain amount of experience, and then only for those children who have the talent. Not all children are able to catch on to the intricacies of the computer programming.

(iii) It would certainly require more than the ten hours allocated to this activity.

(iv) It would probably need more expertise and time on the part of the teacher than allowed for in this course.

(v) Computer programming is not an ingredient of CA.

Further there are some distinct advantages for providing computer programs for use by the children as a part of the activity.

(i) The computer program specially written for the purposes of CA can be presented in parts, demonstrating various functions most suitable for CA rather than carrying out computing efficiently as would be the case (at best) with normal computer programs. This procedure allows the computer program to be represented as a block diagram depicting the function of each part.

(ii) Computer programs as a part of teaching procedure can be written to match computing events with learning events. (This point is discussed on page 179).

It was therefore decided to include specially written computer programs in the kits.

In principle the following sequence of learning events would take place if a module was properly organised to meet the requirements as described earlier:
(i) Children will learn about a situation as it exists before computers are used.

(ii) They will then become aware of the role a computer may play in solving some of the information processing problems, but only in principle.

(iii) They will accept the concept of a computer system as a whole, which may be applied to the situation in hand.

(iv) They will then carry out computing using given computer programs for each part but in the context of the whole.

(v) They will run the whole system.

(vi) Throughout the activity they will encounter the properties of computer systems relevant to CA.

As can be seen each module will include experience of a computer application as well as of the properties mentioned.

Application of science to solve practical problems involves more than the basic findings. For example, to use the science of electronics to produce hi-fi equipment requires an appreciation of the needs of the users of this equipment, their taste and possibly some knowledge of music. In this sense, once the basic findings of science are accepted, a technology becomes an art. This applies to educational technology perhaps even more than most other technologies. The justification for implementing a particular strategy of presentation therefore is not of the same nature as a scientific proof. If a strategy cannot be accepted a priori or by analysis based on a priori principles, then it must be justified by results. But once again the results of an evaluation of an educational material do not have the same status as the results of a scientific experiment. At some point, therefore, a value judgement has to be made as to whether or not a particular strategy is acceptable.
The various applications considered originally were

(i) Public Utility Billing by Computers
(ii) Stock Management by Computers
(iii) Planning Routes for Police Cars
(iv) Computer Aided Learning
(v) Siting of a New Warehouse
(vi) Model of National Economy
(vii) Seat Reservation for Airlines.

The idea was to scan as much of computer applications area as possible. Public Utility Billing would provide the background for the most common contact lay people have with computers, that is through gas or electricity or similar bills they receive. Stock Management would demonstrate the central role the computer systems are now playing in what is known as Management Information Services for many companies. In addition to this, due to the use of computers, some companies have actually succeeded in reducing the stock they hold and reduced or eliminated distribution units. Planning Routes for Police Cars would be useful in relating the speed of information processing with possibly saving of lives. Computer Aided Learning was considered useful because it is likely that some children will come across the computer in this mode and it would be a good thing if they knew something about it. It had the added advantage that the subject area was immediate to children. Siting of a New Warehouse would demonstrate the use of a suite of computer programs for analysis once only and still save costs, in addition to helping with raising the quality of decisions. The use of a suite of computer programs once only is an exception to the general rule and is therefore worth mentioning. Model of National Economy is a brilliant example of computer simulation and would demonstrate this aspect of computer use. Seat Reservation for Airlines is a good example of what is known as Real Time Computing - in which the computer is an integral part of a system whose state is continually changing.

At the time the first drafts of the first two modules were written the only computer language available for use on the terminals was Telcomp Two on the commercial machine Time Sharing Ltd. The first module (referred to as kit from now on) to be tried was Gas Billing by Computers. This
kit served a useful purpose in the development of the material. During the initial trials with children it showed critical areas to watch for the rest of the development. One of the interesting points discovered was that children made more typing mistakes than any others - and often this led to the machine printing some error messages not easily understood by children. This provided the first one as to what needs to be covered in the introductory kit (Educational Module Type B). After about four drafts an acceptable shape of the kit emerged.

The second kit to be tried was the Stock Management by Computers. To this end the author paid a visit to the head offices at Watford of the chain of stores trading under the name of "Mothercare" - to whom he owes so much. This company uses the computer to make forecasts based on the stock record, which in turn is used to inform the manufacturers of expected orders months in advance. Then taking into account the seasonal fluctuations and the fashion trends, and in consultations with the buyers, firm orders were printed out by the machines and sent to the manufacturers along with a cheque post dated one month from the expected date of delivery. This procedure helped the manufacturers and improved their efficiency in meeting the deadlines, etc. As soon as the orders were received by the branches in various High Streets they detached the 'Kimbal' tags (kind of miniature punched cards) and sent to the head office, where they were read by the special card readers. 'Kimbal' tags were also returned by the branches for all the sales they made. This way a strict surveillance was kept on the goods ordered, received, sold, paid for, etc., without them being handled via a warehouse. The extent to which the computer was used can be demonstrated by one simple but interesting example. It was discovered that a manufacturer of one item was consistently being late in supplying his product in spite of all the advance notices he received. On investigating it was discovered that he never remembered to order hangers until the goods were ready which meant an inevitable delay. The company started sending the computer prepared advance notices and orders to the suppliers of the hangers on behalf of the manufacturer.

All this meant that the company got rid of the central warehouse altogether, except for the small stock they keep for mail order, and all their delivery vans earlier used for distributing goods to the branches.
Fascinating that this particular application is, the knowledge of company procedures required to appreciate the role of the computer system 'Mothercare' style was such that most children in the target population did not possess it. An attempt was made to include the information regarding how a company is run in the first part of a possible kit, followed by the use of the machine in the manner indicated. It became obvious very quickly that this approach will lead to at least two major problems. First, it will definitely include more work regarding commercial practices than that concerned with computers. This may not necessarily be undesirable in itself, but because there is so much to learn outside the declared objectives of this course the actual development of CA might be only marginal. Second, this kit would have taken at least three hours to complete by children, and this would mean unacceptably high weighting in a total course of ten hours. This kit therefore was never completely written in this form.

The form which finally emerged included a subset of what is described above, that of stock records.

A feedback procedure on both the kits soon paved the way for a standard format for the kits. This was done by getting the children to fill in a feedback sheet. The feedback sheet itself went through the processes of formative evaluation. This sheet was based on the feedback sheet originally developed by the Institute of Educational Technology, University of Surrey, for undergraduate courses. A full discussion on the feedback takes place in Chapter

At this point in time the interactive computing facilities were made available to the schools by the University's own computing establishment. The kits were now developed on these facilities using the computer language JEAN. (For justification for choosing this language as against others available see page

Because the South Eastern Gas Board refused to give permission to include this subject for a kit, the first kit Gas Billing by Computers was not translated into the new language and all the existing known copies except one were destroyed. Stock Record by Computers was completely rewritten using JEAN and incorporating all the lessons learnt from the feedback analysis of the
original kit. A fresh feedback procedure was, however, undertaken for this new copy of the kit.

Planning Routes for Police Cars also turned out to be more complex than was thought appropriate to the situation. This time the difficulty was in writing a computer program which, on the one hand, did the job of computing the fastest route from a given point to any other point on the map and was simple enough for children to realise conceptually on the other. This point is clarified further on page 180. Instead Planning Routes for Fire Engines was implemented as it required computing the fastest route always from the fire station to any point on the map. The matrix of points was much simpler and was later found to be within the reach of the target population.

Computer Aided Learning was implemented as originally considered.

Siting a New Warehouse required investigating the architectural practice as this expertise was outside the reach of the author. To this end help was sought from Mr A Kirk, Chief Architect, Consortium of Local Authority, South Group, Camberwell, London SE1, who spent not an insignificant amount of time with the author and gave invaluable help in developing this concept. After a few discussions it was decided that a better subject, still in the same general area, will be Computer as an Aid to Planning Committees instead of Siting of a New Warehouse. One of the reasons for this switch was that, once again, the information required about commercial practices to implement the original idea was beyond easy access of the target population. The other reason was that the use of computers by Local Authorities was a new area of application as against the original commercial area which was already covered in Stock Record by Computers.

The kits Model of National Economy and Seat Reservation for Airlines were both found to be too complex to be suitable for bringing out the main properties of computers at awareness level.

Therefore the final list of the kits in this category (Type C) was

   (i) Stock Record by Computers (Module 3)
   (ii) Computer Planned Routes for Fire Engines (Module 4)
The original idea was that all the kits should be at the same level and that it should not matter in which order the kits were done by the children, to allow maximum flexibility. However, after a while it was realised that one kit in this Type should relate directly to the Introduction to the Computer Terminal (Type B), with others following on in any order. 'Stock Record by Computers' filled this role.

One kit, Computer as an Aid to Planning Committees, is described in full in chapter 9. But first some special features of these kits are described.

8.3 Some Special Features

8.3.1
In all the kits the actual learning instructions were provided on the right hand pages. These instructions were numbered and were followed sequentially. The colour of the right hand pages changed every time the category of the information included in the instructions changed. For example, in the 'Stock Control' kit first four pages dealt with a look at the overall system, setting up of the system part at a time, and providing the input procedures. All these activities can be considered as related to the setting up of the system. These pages therefore had the same colour. This was followed by activity related to information retrieval which is clearly different and another colour page was used. The subsequent activities dealt with errors, with the computer program and with using the same system for banking. Various other coloured papers were used for these pages. The reader is asked to contain his impatience for justification for the sequencing of the events, and for including them at all for a little longer. At this stage the only point to note is that the colour of the paper was used for two purposes. The first was that a new colour on the right hand page announced the start of a new activity so that the learner prepared himself for it. The other was to let the learner feel that he has 'successfully' completed one element of the learning activity.
The left hand pages were all blue and were used for the following purposes.

(i) To provide continuously an overall picture of the system under operation to meet the requirement (E(ii)) from the Summary of Requirements. The overall picture was provided in the form of an outline of the system in which the relationship between constituting parts was shown. However, when the activity related specifically to one part, the outline of the part was heavy lined within the outline of the whole system. This applied to all the kits all the time with rare exceptions. One notable exception is the kit on 'Computer as an Aid in Education' as it was felt that the information provided on the right hand pages was enough to meet this requirement. Another exception is opposite page 7 of the 'Stock Control' kit where the computer program is listed. Even there, various parts of the whole system are indicated.

(ii) To provide additional information necessary to carry out the instructions on the right hand pages. For example, a map of a town was required for the kit 'Planning Routes for Fire Engines' to run it. Site plans and other visual aids were required for the kit 'Computer as an Aid to Planning Committees'. A line drawing of the keyboard was required for 'An Introduction to the Computer Terminal'. All these were given on the left hand page.

(iii) To provide information while which could be provided by the learner himself would make smooth running of the module easier. For example, the learner is invited to provide stock levels for various commodities himself at the start of the computer file (see page 2 of 'Stock Control'). But it was found during initial trials that most learners found it difficult to take their mind off running the computer program to think of suitable figures for this purpose. Another example of this can also be found opposite page 6 of the kit on 'Fire Engines', with regard to delays due to special hazards.

8.3.2

Any learning material for computers is bound to include a certain amount of 'computer jargon'. The new words arising out of this and out of the
applications discussed were introduced 'in use' thus implying their 'meaning'. Definition of the words were avoided. The word INPUT and data (instruction 6, page 2, Stock Control) were thus included in sentences which implied their meaning. (Also so last two lines on page 5 of 'Introduction to the Computer Terminal'.) Similar examples can be found throughout the kits.

8.3.3

Whereas writing computer programs is not part of the objectives of the material for CA, what a computer program looks like is. There is need to show learners the listing of the computer programs. Since it is required that the learner is involved actively with what he is offered and that he perceives each event in the context of the whole, it is not enough that he be shown a listing of the computer program and told, perhaps, 'this is the program you have just used'. To overcome this difficulty the listings are provided as continuing activity. The first time (page 7 of Stock Control) the program is given and described. The learner has just finished operating the system (using this program) in parts. He is now asked to join part 2 with part 3 and run the whole system thus confirming for himself that the listing he has just seen and modified is real.

The second time (page 9 of 'Planning Committees') the learner has just finished running the system in parts and obtaining the cost of implementing one proposal out of many for housing development. Now he is offered to join the various parts together and run the program for as many times as required and compare the costs.

On both occasions the learners have an opportunity to look at the computer program to any degree of depth that their present state of 'recognitive map' and needs require. It is considered sufficient that the learners see two computer programs as at awareness level most computer programs will probably look alike.

8.3.4

It is true that to use an existing computer system meant for one application for major new application, some new machinery is needed. For
example, it is difficult to use a machine which is basically for data processing to operate point of sale terminals without major hardware modifications. However within a certain category of use the variety of applications possible on the same machine is large. This can include applications which in the view of a layman are dramatically different.

To give some idea to the learner of this special feature of computers a brief experience of another application following the main one is given. On page 8 of Stock Control the learner uses a system 'BANK' which for all intents and purposes and in essentials is identical with the main applications he has just investigated. To a learner Stock Control and Banking are two rather dissimilar areas.

To the same effect on page 12 of 'Fire Engines' kit a system for a Lending Library is given. Once again the outlines of the systems are similar but the areas of application widely apart.
The general objectives of all the Modules Type C are the same. The specific application the learners experienced, of course, changed from one Kit to the other. The actual properties of computer systems emerged naturally out of the subject matter of each kit and hence were defined retrospectively except that a prerequisite that the sum of all the computer properties of the total course must meet the requirements for CA (see (c) in the Summary of Requirements). This list is provided separately on blue sheets in the pocket.

**Target Population**

Age ranges: 11-18 years

Ability ranges: All

Sex: Both

**Objectives**

1. Learners will experience the computer application to Local Authority Committees.

2. Learners will experience the following computer properties:

   (i) The computers can be programmed to check some errors while the computer files are being built.

   (ii) Computers are capable of maintaining data files and they allow easy access whenever there is a need.

   (iii) Computers are much faster than humans to carry out calculations.

   (iv) Computers can print out the processed information in a desirable format.

   (v) Computers are capable of producing results which have various human implications.

   (vi) Computers cannot make final decisions.
Pre-knowledge

1 Learners have gone through the Tape/Slide (Module 1).

2 Learners have carried out the work prescribed in the kit "Introduction to the Computer Terminal" (Module 2).

3 Learners have carried out the work prescribed in "The Stock Control Kit" (Module 3).

9.1 General Description

The application area selected for this kit was the cost analysis for housing development on which members of a Local Authority Planning Committee can base their decisions. Before the learners can appreciate the use of computers in this situation clearly they need to be made aware of the way Planning Committees work, for it cannot be assumed that the learners have this knowledge. First three pages are therefore devoted to this purpose. Page one describes briefly the job of the Planning Committee and how computers may aid in this job. A map of a real site in London is given on the left hand page, showing the complexity of the job.

Page 2 describes an imaginary site (the map of which is provided separately) for development. To help the learners visualise the siting of houses and the way they are distributed within a given area two maps are given on the left hand page: one perspective and one plan (drawn by Mary Ince of the South London Consortium). A distinction is made between the number of houses and the number of persons for whom housing is provided: for it is traditional in the 'Planning Trade' to work out the housing costs per person rather than per house.

To help learners to appreciate the magnitude of the area represented by each square (100 x 100 metres) on the site plan a comparison is made between the size of tennis courts, of football pitches and the size of each square and the size of the whole site respectively.

Finally the learner is put in the position of a planner and is given the task of planning.
This task, which deals only with housing, is described in some detail on page 3 and various aids are provided to make this task easier to the learners. A quick look at page 3 will show how this is achieved. The net result of the activity on this page should end up with 5 or 6 plans for housing created by the learners, and corresponding data regarding the number of houses rehabilitated and built on a piece of paper. The reader is invited to make one plan himself to appreciate the utility of the aids used.

Up to this point the use of the computer was not involved, though it was mentioned how it may be used in this situation. Page 4 and opposite page introduce the computer system for the first time in this kit. The system has 5 parts: each part defined according to function it performs and the diagram shows how each part is related to the whole and to each other. In subsequent pages the learners will 'operate' each part within the whole system.

Up to now the work prescribed was carried out by children without sitting at the computer terminal and logging in.

Page 5 gives instructions to start using the machine and do Part 1, which is only concerned with inputting factual information regarding the existing site, etc., originally provided by the surveyors. This information as well as the outline of the system with Part 1 heavy lined is given on the opposite page of the kit. Learners get experience of building a computer file. A refinement of the use of the computer viz. checking some errors while the files are being built is also experienced by the learners, and a composite statement regarding both the building of the file as well as this refinement is given at the end. This is an attempt at reinforcing two properties learnt earlier (Computer Properties nos. 6 and 11) and consolidating them.

Page 6 deals with Part 2 which is concerned with inputting information regarding housing costs. The opportunity is used to reinforce the experience of an earlier computer property (no. 14) that regarding maintaining computer files and a statement is made to this effect.
Page 7 gives instructions to learners to provide yet more information in part 3, this time regarding the number of houses to be rehabilitated and built from the learner's own records.

It may be useful to stop here for a minute to ask why was it necessary to provide INPUT in those parts when it could have been provided all at once? The reasons are partly logical but mainly practical. First the three bits of the information are categorically different: the first deals with the details of the site, the second with the costs and the third with the number of housing rehabilitated and built. Each bit of information has different sources. The details of the site are provided by the surveyors, the costs of rehabilitating and building by the quantity surveyors and the number of housing by the planners, in this case by the learners. Finally the details of the site are permanent, in the sense that it remains the same throughout the deliberation of the planning committee even if it takes months. The costs of housing per person remains steady throughout the run of the computer program but may change even through the length of time a committee considers various proposals. The number of rehabilitated and built housing changes from one proposal to another through a single run of the computer program (see page 9 of this kit).

Once the machine has all the information the learner will probably be keen to see what it will do with this information. Parts 3 and 4 are therefore provided together. However one computer property to be brought out at this point is their speed compared with humans to carry out calculations. To this end a sample calculation done manually is provided on the opposite page and some remarks made about it on page 7. This page ends with processing Part 4 and the statements regarding the two computer properties just demonstrated.

Page 8 is organised round a subject which is not generally considered important by many computer system designers. Human Implications are varied and have a complex base and generally are not quantifiable. But in a limited way, when quantitative analysis is possible, computer outputs can be organised to make obvious what is only latent otherwise, provided the system designers and users are sympathetic towards this approach. One human implication in the present study is the number of children
affected adversely as a result of the development. It may not be possible to catalogue the experience of each child dislocated but the machine can certainly be programmed to estimate the number of children involved. If this point is successfully realised by the learners, they may in the future be sceptical about general attitudes of those in authority that computers can only carry out financial analysis, etc. Development of the critical approach by the learners is considered an essential part of Computer Awareness.

This and another awareness statement that 'Computers cannot make final decisions' conclude this page.

During any run of the computer program for this module, Parts 3, 4 and 5 have to be run a number of times depending upon the number of planning proposals considered. The learners are asked to join these parts together by simple statements given, thus making this job easier. This procedure implemented by learners is used to advantage for another important purpose. A listing of the computer program is provided opposite page 9 which allows the learners to relate the two statements already mentioned to the whole programme, thus giving them an idea of what a computer program looks like.

The page ends with advising children to place the results of all the outputs side by side to decide which proposal offers all-round advantages. It is not considered necessary to instruct the learners in what criteria to use to make this decision in addition to what was suggested and implied in the earlier pages of the kit.

9.2 How this module meets the stated requirements

From the Summary of Requirements it will be obvious that some of the requirements are met can only be demonstrated by valuation, and therefore are dealt with in the section on evaluation. The requirements which concern the structure and the content of each module are discussed here. These are mainly found in (C), (D) and (E) of the Summary.
(C) **CA Requirements**

(i) **Experience of computer properties relevant to CA**

These are given at the start of this chapter as well as on blue sheets as nos. 33 to 38 and of course in the kit. The reader may like to check for himself that they are all relevant to CA and are included in the kit as 'points to remember'. Each property, before it is stated, is demonstrated as part of a learning activity. For example the property on page 6 'Computers are capable of maintaining data files and they allow easy access whenever there is a need' is demonstrated by the learner to himself by reading the files for values of a number of variables such as C(3), A(99), etc. Likewise the property 'Computers are much faster than humans to carry out calculations' on page 7 is demonstrated by showing the children a manual calculation followed by an equivalent processing by the machine. Also the second property on this page is demonstrated by the actual computer output.

(D) **Requirements arising out of use of self-learning package on interactive computer terminals**

(i) **Computers should not be used for instruction**

At no point throughout the kit does the machine actually print out an instruction for the learner to follow. The nearest it gets to it is to print an error message when an error is actually made. This in fact is an integral part of a computer system and CA should include an awareness of this facet of the machines.

(ii) **The actual typing by the learners to be kept to a minimum**

There are only between 32 to 40 lines of an average length of 15 characters to be typed for the whole of the kit.

(iii) **The effort required to use the material in activities other than learning itself is kept to a minimum**

This was achieved by the following means:

(1) No reference back or forward or indeed to other kits.

(2) The outline of the system is given as often as required at the appropriate places with parts under discussion thick lined.

(3) Site plans and colour card pieces are given as an aid.
(4) The text is not excessively verbose regarding details about items not directly related to CA and which do not contribute towards completeness of the situation under discussion.

(5) Additional information to carry out instructions is given at the places required rather than altogether in one place.

(iv) is dealt with in the section on evaluation.

(v) should be obvious from the kit.

(vi) applies to the whole course and can be checked from the blue sheets.

(vii) applies to Module 2 (Introduction to the Computer Terminal).

(E) Requirements of the Method of Learning

This Module can be thought of as made up of two separate structures, one dealing mainly with planning and the other mainly with the use of computers. Both structures in fact should meet all the requirements of the learning method separately except that the reinforcement procedure of making statements of what might have been learnt in pages 1 to 3 are avoided, against great temptations. The rest of the pages (4 to 9) deal with the subject of CA proper and are discussed here.

(i) The initial activity is largely within the existing cognitive map of functional units of the learners

Page 4 can be considered the starting activity and with the preceding pages should be within the reach of all or most of the target population, as very little is assumed on their part.

(ii) At the start, and subsequently, it is perceived by the learner as a whole in which properties of each part are related to other parts and to the whole

The system is presented as a whole with 5 parts. From the outline of the system it can be seen how each part is related to the whole and to other parts. This is achieved by presenting the information for each part at the same functional level. Later on while each part is dealt with individually, in some detail, it is always presented as part of the whole. Further the details of each part always make a contribution to the perception of the
relationship of the part to the whole. For example the instruction to the computer 'DO PART 1' implies that there are other parts of the whole system, and indeed the actual information provided to the machine for this part is only building the whole system. The computer program utilised is so organised that each part of the program relates directly to each part of the system. This applies throughout the kit. For example on page 7 parts 3 and 4 are dealt with together to show the relationship between the provision of information and the processing carried out by the machine.

(iii) **It is dynamic in which each event that takes place is perceived by the learner to be related to the previous event and is expected to be related to the events that follow**

One easy approach to demonstrate this requirement for the module is for the reader to follow the kit on a computer terminal. However an attempt is made in the following paragraphs to describe procedures adopted to try to make the module dynamic and consistent.

To make the explanation simple, the module is considered from page 4 onwards, the first three pages being devoted mainly to planning.

A series of cognitive events may be considered dynamic when there is a reasonably fast movement from one event to another but related event. It is not enough that there is a reasonably fast movement from one event to another if the events are not perceived by the learner to be related. Thus going back to the analogy of the cinematograph film, if a set of frames show a person just diving off a diving board which is followed not by a splash in the pool but a motor car crashing into a tree it will not meet the present requirement. There is a movement from one event to another and a fast movement at that, but if the events are not perceived to be related the viewer will be hard put to learn the diving technique of the diver.

At the time the learner reads page 4 he already should have a number of proposals for housing development which he needs to process to make final decisions. To utilise a computer system
for this purpose he is first given an overall view at a comparatively high functional level. The two sets of information, given on page 4 and his own, are thus related yet there is a real cognitive movement from one to the other.

Page 5 follows on to login to the computer, call the computer program and carry out the procedures to implement Part 1 of the system. Implementation of part 1 of the system is obviously related to the whole system and indeed there is a quick movement from the whole system to the implementation of part 1. The learner should expect the following event to be the implementation part 2 and then parts 3, 4 and 5 which is exactly what takes place.

However, while implementing each part short excursions are taken into lower functional levels and into experiencing computer properties relevant to CA. The point of interest to note here is that provided the events are related and the jump from one functional level to another is not too big this digression should not cause any cognitive discord. The problem arises when the jump is too big or when the category of knowledge is suddenly changed.

Having quickly gone through the system (total time of implementation as evaluated is 33 mins See page 204 ) the learner should be seeking to run the whole system in one go for all the proposals. This is in fact what he is offered on page 9.

(iv) That the learner perceives an imperfection in the relationship between his cognitive map and the perception of the system at the start or soon after

Towards the end of page 3 the learner should have a number of planning proposals. He is told 'You can, of course, work out yourself how much each proposal will cost if carried out. But you will find, in the following pages, how a computer may help'. How a computer may help to carry out the processing is not a part of the cognitive map of the learner as yet. He will therefore perceive an imperfection and will wish to remove it. On page 4 he is offered an overall view of the computer system
which should start to remove this imperfection. Towards the end of this page he should then feel how he can actually use the system. On page 5 he gets his first contact with the machine to implement part 1, but in the context of the whole system. At this stage if the learner is aware of the system he will perceive that he does not know how to implement part 2. This carries on until he has successfully (in his own mind) implemented all the parts of the systems.

By the time he has finished implementing part 5, the learner has processed the first proposal. He may think "I have 5 more proposals. I hope I do not have to go though that again". This should result in searching his cognitive map for a procedure to shorten the procedure for carrying out the rest of the processing. If he does the statement on the top of page 9 "Obviously it will be easier to run Parts 3, 4 and 5 altogether once N(2) and N(3) have been put in" will reinforce the perception of the absence of the necessary functional units in his cognitive map. If he does not this statement should soon result in this activity. It may be useful here to point out that it takes much longer to explain how an imperfection is perceived by the learners than it takes to actually perceive it.

(v) The action required to remove the imperfection as perceived by the learner will result in the acquisition of functional units, as envisaged by the designer of the system

The functional units which the course writer desires the learners to acquire are the computer properties relevant to CA.

Once an imperfection is perceived by the learner the action taken to remove this imperfection should result in the experience of one or more of these properties.

Consider, for example, page 7 of the kit. The learner has just perceived that he does not know how to implement part 3 and then how to process the information using the machine. In fact in instruction 13 he is asked to look at the manual calculations opposite the page and he should be, at this point, seeking to use
the machine for the same calculations. While removing this
imperfection he experiences the speed of the machine as well as
the ability of the machine to output the processed information
in a desirable format. Thus the action taken by the learner to
remove this imperfection results in his acquiring two functional
units which the course writer had found desirable.

Similar attempts made by the author may be noted on pages 5,
6 and 8.

(vi) The effort required to learn is commensurate with the learner's
motivation to remove the imperfection, i.e. the learner succeeds
in removing the imperfection before he exhausts his motivation.

Once an imperfection is perceived a motivation exists to
remove it. But the magnitude of this motivation is not limited.
In any case there are other imperfections being perceived by the
learner at times such as caused by a little noise outside the
door or a piece of rubber missing from a foot of a chair, etc.
This suggests that unless the induced imperfection is not removed
more or less immediately the learner will be doing some other
learning not planned by the course writer.

In the kits this is achieved by reducing the activities which
do not contribute directly to the objectives. Typing is one
such activity. Only 67 characters need to be actually typed
by the learner, unless, of course, he makes a mistake, to carry
out the total task prescribed on page 5. The reader may like
to check that for himself from the sample output provided
separately.

The information needed by the learner to carry out the instructions
on each page are provided with their pages rather than altogether
in one place, either at the beginning or at the end of the kit.

Another source of demand on the effort made on the learner found
in common practice, when the learner is given various bits of
information which he has then to put away (generally in his mind)
for a period of time before it is utilised. In the kits the only
information which the learners are expected to keep relates
directly to the learning objectives. All other information is
provided for immediate use. There is therefore an effort required
to memorise, albeit temporarily, any information which concerns
only the activity in hand and has no bearing on learning
objectives. Quite often it requires repetition such as
reproduction of the outline of the system practically on all the
blue pages.

(vii) Every time that the learner renders the relationship perfect
he is offered a fresh imperfection until the learning goal, as
envisaged by the designer, is achieved
This has already been dealt with under (iv).

(viii) At all times during the sequence the system (which is being
modified as events take place) remains within the cognitive map
of the learner, intended imperfections excepted
This is achieved by keeping the functional levels and functional
categories of the information provided remain more or less the
same. (This point was dealt with in section 2.2.2.) And when
either the level or the category of a new piece of information
is changed it is always related to the previous information,
i.e. the new functional unit offered is always related to an
existing functional unit in the cognitive map of the learner.

Thus when a learner is asked to 'DO PART 1' on page 5 he has no
difficulty in recognising the system to which part 1 refers, as
he has recently been given the information about it. Likewise
when the category of information is changed from planning
(pages 2 and 3) to the computer system (page 4) the learner can
easily relate the two. This continues throughout the kit.
CHAPTER 10

EDUCATIONAL MODULE TYPE B

10.1 OBJECTIVES 162

10.2 DEVELOPMENT 163

10.3 USING THE KIT 164
An Introduction to the Computer Terminal

After the learner has acquired a visual and conceptual image of the computer through viewing the tape/slide he should go on to experience computer properties relevant to CA by using the kits in Type C. However there were two major reasons why they could not start on kits Type C straight away. The first was that they did not possess the skills to operate the computer terminal and it was felt desirable to separate teaching of this skill and teaching of CA using this skill. The second was that the children seemed to have an inherent dread of 'operating the computer'. In this situation, unless they were at ease with the machine by getting it used to its noises, its responses and its other peculiarities, they would find it difficult to appreciate the properties of the computer relevant to CA. From these general aims the following specific objectives emerge:

10.1 Objectives

(1) The learners will experience typing on the computer terminal.
(2) The learners will experience some special symbols utilised by the computer terminal e.g. * (multiply) and ↑ (to the power of).
(3) The learner will experience login and logout procedures and use the machine for some elementary processing.
(4) The learner will experience some error messages for the machine.
(5) The learner will experience some remedial procedures when an error is made.
(6) The learner will experience procedures for recalling and using a stored computer program.
(7) The learner will experience the following CA properties:
   (i) Computers are capable of reproducing a text.
   (ii) Computers are capable of handling numbers and words i.e. are capable of information processing.
   (iii) Computers are capable of storing information.
The initial difficulty to overcome to start children using the computer terminal was to alleviate their inherent fear of 'operating the computer'. The root cause of this was identified to lie in the situation when the computer suddenly started typing as a response to some input from the learner as if it has a will of its own and it did that rather noisily. This response was so much out of the ordinary experience of some of the learners to cause distress and there was a real fear to lose some learners for ever. It was also detected that some learners were at a loss to decide as to what to do when the machine finally stopped with the message

**TYPE YOUR JOB NUMBER**

even when they were offered the actual characters to type. It seems that a live computer terminal is categorically different than any other machinery the children might have come across.

It was decided to split up the total experience of using a computer terminal in a number of steps each one meeting the requirement of being within the existing cognitive map of functional units of the learner.

To this end the first statement made to the learner is that a computer terminal is nothing more than an electric typewriter with one or two exceptions. Some learners may not in fact have experienced an electric typewriter but most, if not all, should have a certain amount of 'typewriter awareness'. Each instruction on page 1 and 2 was written to give enough information to the learner to enhance his feel of the keyboard - the sum total of instructions 1-14 giving sufficient experience to cope with the typing involved in the kits Type C.

In the original version of this kit, the learners were asked to type a given passage for practice. But trials showed that even a moderate sized typing exercise resulted in many mistakes. This part of the task was eliminated from the final version. There is conflict between teaching children to type adequately which takes time and allowing children to get on with learning about computers which must meet the requirement B(vi), which states that the effort required to learn is commensurate with the motivation. Rather than lose some learners if they could not learn to type well, it was decided to reduce the amount of typing in all the kits.
To clear the working space in the machine to use it for a fresh activity.
To recall a stored program and use it.
To restart the program when an error is made.

The reader may like to check that the kit includes all the above facilities. Although the kit was designed mainly for the objectives indicated, opportunities were not missed to include some CA statements whenever they arose. See last two statements on page 5 and the statement after instruction 12 on page 7.

10.3 Using the Kit

An attempt is made here to explain how the kit, the computer and the learner might form an integrated system for the duration of the operation. It may be useful to go through the kit as a learner might during a typical session and to try and guess, approximately, what he might experience. It is not pretended that the author has a definitive understanding of the human mind but if no attempt is ever made to look at a learning material from the learner's view point, then Educational Technology might as well confine itself to SR techniques. The sole purpose of this exercise is to see efficacy of the learning sequence prescribed.

Sample outputs for all the kits are given together in the pocket at the back of this thesis. The reader will need to have the kit "An Introduction to the Computer Terminal", the sample output and the copy of instructions for logging in and logging out hung on the wall in front of a terminal.

On reading the first paragraph on page 1 of the kit, the learner might say to himself something like 'I didn't know that the computer terminal was like an electric typewriter'. But he will also feel that the two pieces of equipment are not identical, viz capital letters only and some special characters. The information in this paragraph should be within the cognitive map of the learner. This paragraph should also generate a feeling of imperfection in the learner in that the teletype utilises capital letters only and there are some special characters. He also might lack the actual experience of operating such a machine. The last two statements should result in reassuring the learner that he will successfully accomplish the activity prescribed.
Following the instructions the learner should switch on the Power Supply, turn the knob at the front of the terminal to LOCAL and strike the RETURN key. He should type K and then L. At this point he should have heard the first noises the machine makes. This is followed by the learner typing shift and S/, thus demonstrating to himself the operation of the SHIFT key. Note that no definition of the operation of this key is offered to the learners. He also experiences the operation of the key marked NEWLINE.

The learner should now be ready to type a few characters successively as the noise or the slight judder of the machine will not disturb him any more. Out of the four lines on the keyboard he is first asked to type the top line as he is more likely to have come across numbers 1 to 9 in order than, for example, the letters QWERTYUIOP which are neither the natural sequence of the English alphabet, nor do they amount to a recognisable word. After typing this line he once again strikes the NEWLINE key. The resultant response by the machine is sufficiently fast that the learner might not notice that, in addition to the printing head returning, the roller has also turned to a new line. This double action is therefore pointed out to the learner. He is offered to prove it to himself if he so desires.

Instructions 5, 6 and 7 should get the learner to type all the available characters including the upper case ones. As a result of the instructions so far the learner should have experienced the feeling of using the keyboard of the teletype, its idiosyncrasies and its peculiarities.

The fact that the control key is by and large imperative OFF LINE is brought to the learner's notice. Nothing happens when he strikes BRK and CNCL keys while the CTRL key is depressed. He is therefore (pleasantly!) surprised - striking BELL in fact rings the BELL! He is asked to try it again just to reassure himself that it wasn't an accident!

The learner demonstrates to himself the action of the REPT key for lower case characters in the first instance by following instructions 9 and 10. It is possible that sometimes during the course the learner may have to type upper case characters repeatedly. This requires using three keys and the learner proves to himself that it is possible to achieve this with two hands only by following instruction 11.
Although the learner has already typed the characters *, and /, their significance is pointed out only in context, that is by using them in appropriate expressions. By following instructions 13 and 14 the learner should use these symbols for the first time. To help him identify the keys quickly a diagram of the keyboard is given on the opposite page pointing out the appropriate keys. The opportunity is also used to reinforce the existence of some other keys.

On page 3 the learner is reminded that the computer terminal is connected remotely to a computer (the reader will recall that this information was originally given to the learner in the context of a trial computer system while he was viewing the tape/slide) and is generally prepared for logging in.

Getting online and logging in for the first time is the only procedure which is not self-learning. Teachers in trial schools or their sixth form deputies helped the learners to log in for the first time. The instructions for this procedure were hung on the wall and the learners were never offered any personal help on this count again, unless, of course, they asked for it. (For number of times help required per kit see page 201.)

Instruction 2 on page 4 explains to the learner the function of the typed by the machine. Although he has actually seen the back arrow during logging in, this is the first time he will respond to it on a regular basis. Once again the point to note is that the learner is offered information at the critical stage when he has just observed something he does not quite relate to (perception of imperfection) and is motivated to act to remove this unsatisfactory state of affairs. Further, this information is given to him in the functional context and the effort required on his part to acquire this new functional unit is low, commensurate with the motivation.

The learner learns that there is a computer language called JEAN, that he is going to use it and indeed how he can use it.

Instruction 4 demonstrates one of the primary properties of the computer and a statement of this effect is made at the end of it. But the instruction starts with a statement which related it to what has gone on before.
Although the learner has used only a few statements up until now it is not too early for him to learn some of the evasive action he can take in case he makes some typing mistakes. Because functional learning approach is used in developing this material there is a conflict in the needs of the learner at about this stage of his learning in this kit. It is possible that he makes a typing error before he carries out the instruction 5 and thus gets in a state out of which he cannot get out by himself (this is because the machine would print out an error message). On the other hand how can a learner be taught a procedure to deal with exceptions before he has some awareness of the rules? If he is given this information outside the functional context before he carries out instruction 4, then this contravenes the general principles on which the whole of this work is based. It was felt desirable that there should be some help available for learners who might get into difficulties doing these kits in any case. This was partly because even if the learning material was entirely teacher-independent, there were always situations, such as systems failure, when somebody experienced was required to interpret the events. It was however found during evaluation that the number of times help was required was minimal (see page 201).

First the learner is asked to make a deliberate mistake in typing and then told how to eliminate the whole line before it is transmitted to the computer. Clearly the next question the learner will be asking is 'I wonder what will happen if I do let such a statement through?' He can find out by carrying out instruction 6.

Although there is a facility available to correct a typing error, the facility to rub out the whole line is sufficient to cope with the situation at this stage of learning. The other facility, though more appropriate to correcting errors, is more involved and is left until later in the kit (page 6) as the learner would be keen to carry on with some more "computing".

Instructions 7 and 8 complete the initial glimpse of the computer and end with two statements relevant to CA. The learner should be relieved to see that experience of the computer terminal as a calculator and reproducer of the text is brief as typing is one of the most persistent sources of learner error.
"Tricks of the Trade!", the title of the next task on page 6 should result in fresh motivation for the learner to carry on. The facility back arrow has various uses for eliminated erroneous characters and the learner is helped through their experience. Towards the instruction 10 the learner is asked to let a statement TYPE through to the machine to experience the error message.

Instruction 11 allows the learner to experience a variety of erroneous statements and machine reactions to these statements.

'DELETE ALL' is a statement which the learner will come across repeatedly during the kits Type C. The other facilities he will use are reaching a stored program and statements like 'DO PART 1', to make a deliberate mistake in providing data and to use a facility (GO) to restart the program where the mistake was made.

The user ends by following the instructions on the wall in front of him to Logout.
# PART III

**The Evaluation**

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## A PHILOSOPHY FOR EVALUATING LEARNING SYSTEMS

### 11.1 INTRODUCTION

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11.1 **Introduction**

One of the main features of this course is that it is based on the concept of a dynamic system of learning (as defined on page 105). From this it follows that the feedback procedure includes a procedure to 'tune' the entire learning system during its development, and a procedure to identify the indicators which when evaluated will demonstrate the 'state of tuning' of the system. This point is discussed in detail during the rest of this chapter.

The feedback was therefore organised in four phases. The first three were informal and the fourth one formal. First a chat with some prospective learners as to what they wished to know about computers, and in general principle what kind of educational material they would like to use for this purpose. Second, observing the learners while they were using the material produced and detecting any special hangups they might have with it, followed by an informal chat with them as to any comments they might have to make about it and of course what they might have learnt. Third, after a certain efficacy of the kits was achieved during the second phase, a detailed look at the facility with which the learners used the material and the smoothness with which the whole system (made up of the learner, the kit, the computer program and the teletype) ran, followed by a quick check of whether the learners had in fact acquired any functional units of interest to CA. It was during the second and third phases that a determination was made as to what should serve as indicators for measurement during the fourth and the formal phase of the feedback procedure. This phase included the measurement of interest and difficulty levels, among others, and was carried out on a much larger sample. This fourth phase of feedback, as well as the evaluation of the material, was also included in the later stages of second and third phases. More about all this a little later.

The evaluation of the course for efficacy in meeting the stated objectives was carried out by the interview method by the members of the working
party of teachers already mentioned (see page 112). The reasons for selecting this method as against others are given in Chapter 16. The content of the evaluation was related to the original definition of CA, viz it is taken to be the possession of sufficient knowledge to enable inference, general and social, to be made on the basis of what is seen or heard about computers. One of the features of this part of the evaluation was that the contents of the interviews had two main components: one relating to general awareness and the other to computer awareness. The idea was to make a direct comparison between the levels of general awareness and computer awareness demonstrated by an individual during an interview.

The two innovations: one the concept of the tuning of the dynamic learning systems and second the concept of measuring the difference of levels of general awareness and CA, rather than an absolute measurement of the level of CA, clearly need strong justification and explanation. The first is dealt with in this chapter and the second in chapter 16.

11.2.1 The Concept of Tuning a Learning System

Although the concept of tuning physical systems such as a television set or pseudo-physical systems such as computer compilers is commonplace, its use has hitherto in educational technology been subconscious and incidental, to the best knowledge of the author. A discussion of the concept of tuning a learning system therefore is best started by attempting to appreciate the tuning of a physical system. Perhaps the most common example is tuning a motor car engine. It is a dynamic system of sufficient complexity in which a number of otherwise independent sub-systems must operate with each other to make the whole system run efficiently or run at all.

This system is described in the Appendix in detail. The reader is advised to have a quick look at it if he is not sure of what is involved in car engine tuning. It is expected, however, that most people in the western world are aware of the car engine - this is the reason for its use as an illustration.
11.2.2 Tuning a Dynamic System

The reader is reminded that the object of the exercise is to define, if possible, the concept of tuning for learning systems. Therefore an attempt is made in the following to relate various features of motor car tuning with possible, sometimes unsuspected, aspects of the learning system.

There are two stages of tuning: the first stage ensures starting and is comparatively crude tuning, the second stage is fine tuning and is aimed at getting the best out of the engine, however, 'the best' is defined. It is assumed, of course, that the engine was assembled correctly and that all the components necessary for the engine to run are secured together in their respective places and indeed are of appropriate specification. For if any of these conditions are not met the engine will not start. In the following, the assembly stage and the two stages of tuning may be identified in a dynamic learning system.

The Assembly Stage

In the system under consideration the assembly stage implies the existence of a learner, a computer program, an operational computer system and a set of instructions for the learner. In addition to that it assumes that the instructions are in a language known to the learner, i.e. in English in this case, that either the learner knows how to log in to the machine or it is done for him, that there is enough light in the room where the learner is trying to do his 'learning', etc. Most of what is required is common sense but it is possible to leave out a component rendering the system inoperative and not realise the actual cause of the ensuing chaos. If a child is expected to draw a straight line but draws a line which is not very straight, one might blame the instructions or more likely the low intelligence of the child but rarely the absence of a ruler (if that is what it is irrespective of whose fault it is)! The crude tuning of a motor car engine is done if it refuses to start at all and if it is reasonably certain that the assembly stage has been completed. This stage concerns itself with the adjustment of various settings with wide limits before starting the engine. Thus if the ignition timing is nearly right, the engine will run, and the setting can be more accurately set. Similarly the air-petrol mixture
is set approximately and adjusted again once the engine starts running. The sole objective of the first stage of the tuning is to get the engine started. However, in actuality, there are some settings which cannot be altered once the engine starts running. One example of this is the contact breaker gap. However, for the purposes of this analysis it is assumed that such an adjustment is possible. The learning system lends itself readily for the assembly stage of tuning. Once the system has been assembled complete with a learner it will not be too difficult to check if it 'runs' or not. If the learner sits down at the computer terminal and goes through the motions of reading the instructions, of logging in, of typing, etc., one may assume that the system has started. In reality it may not have, but a few checks should immediately indicate whether it is running. For example, if the learner is typing in the statements according to the instructions and there is a response from the machine, then the system must be running - not only the computer system but the larger learning system. Is the subject learning anything is analogous to asking if the engine will pull the car even if it is running - both questions are irrelevant to the first stage of tuning.

If the system does not 'run', or before an attempt is made to 'run' it, a few checks may be made. It should be remembered that these checks and settings apply when the system as a whole is static. Each setting is made in isolation. It should also be remembered that there is a limited control over the learner although he is the most important component of the system, and to make matters worse each learner is different. For this reason and on general grounds the analogy with the internal combustion engine must only be on the surface. The usefulness of the analogy is confined to demonstrating the concept of tuning in very general terms. The checks to make sure that the system 'runs' were devised over a period during the development and are discussed in Chapter 12 and detailed in Section 12.3. These checks included ensuring that the computer system is actually operational, not only in existence, at the time trials were held, that the language used was within the reach of the learners, that the knowledge assumed on the part of the learners was in fact based on reality, etc.
The Fine Tuning

Getting back to the engine, once it is running an attempt may be made to fine tune it. It is already clear that the controls available are to ignition timing, air-petrol mixture setting and idling speed. What are the objectives of this tuning? Well one may assume that the engine should be tuned to give maximum power for minimum fuel consumption. If a direct measure of this was made then every time an adjustment was made the car would have to be run a few miles to check if adequate power is being delivered. For the total range of adjustments this can be extremely taxing on the resources. There are therefore other checks, some formal and others rules of thumb, which can be applied while the engine is running but not actually pulling the car. One of the most sensitive and rewarding checks is the smoothness with which the engine idles. A slight change of any of the settings disturbs the smoothness. There are other checks which the experienced mechanics apply. For example, the time lag between the opening of the throttle and the increase in engine speed should be minimal or non-existent, if the engine is tuned properly. One type of carburettors (SU) have the facility to check if the air-petrol mixture is too rich or too poor.

In the context of the learning system the evaluator may detect if the system is operating smoothly by just observing how the learner goes through the prescribed procedures. If he stops to look out of the window or generally is restless, then clearly the system is not running smoothly. If he asks for help too often or even once the system is not ideally tuned. What adjustments are required to bring the system up to scratch? Like for any other system, experience can advise as to what is required. Is the language slightly unfamiliar to the learner? Or is he scared of the noise the computer terminal is making? Perhaps the environment is new to him. Once again the actual technique and procedures employed are given a little later. One thing however may be pointed out at this stage. The actual tuning of the learning systems is not as simple as that of the engine. There are no screws that can be turned one way to make the content of the kit easier, for example, and turned the other way to make it more difficult. Every single change has to be made when it is not 'running' and tested again.
The Road Test

In the case of the engine the final test is, say, the pulling power. Of course instrumentation can be used to measure the power output of the engine. As a rule, however, the car may be tried on a road and the state of the tuning may be 'felt' from the way the engine reacts to various controls. Checking the consumption takes a little longer. In the end it is the performance of the engine in pulling the car which gives the final 'proof' that the engine is tuned.

For the learning system this final test must be its efficacy in enabling the subjects to learn with minimum human cost. This therefore is equivalent of summative evaluation.

In the following chapters the procedures and results of the four stages of evaluation, viz. the assembly stage, course tuning, fine tuning and efficacy in teaching (pulling power) are discussed.
# CHAPTER 12

## THE FORMATIVE EVALUATION: THE ASSEMBLY

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CHAPTER 12
THE FORMATIVE EVALUATION: THE ASSEMBLY

12.1 Introduction

Development through feedback was discussed in some detail in chapters 5 to 10. It is not intended to repeat that here. However, in the light of what is said in the last chapter and elsewhere, there are various aspects of Formative Evaluation which need special mention and are therefore discussed in this chapter.

12.2 The Assembly

The main components of the learning system are

(i) The learner
(ii) The computer system
(iii) The computer program
(iv) The instructions.

(i) The Learner

Of these the learner is pre-determined in the sense that there is very little the designer of the course can do to alter him in any way to fit him into the system. However it is possible to alter the definition of the target population being catered for. Generally this alteration amounts to narrowing down the various ranges covered, e.g. 15 and 16 years old rather than 11 to 18 years or 'O' level candidates only rather than all ability. Sometimes the alteration of definition is a shift from one part of the range to another, e.g. 16+ instead of 11 to 13 years. In assembling this course it was not found necessary to alter the definition of the target population from what was originally determined (see section 5.6, page 117) before the course was developed.

(ii) The Computer System

The author had minimal say in the computer system to be employed for use by the learners. The machine available was an ICL 1905F with
computer terminals in the contributing schools. However there was a choice of computer languages available and this turned out to be very significant. There were only the two languages BASIC and JEAN which were available on the computer terminals. Initially it was thought that BASIC had two advantages over JEAN viz.

(a) BASIC had a facility to process text which JEAN did not.

(b) BASIC was an international language available, even in 1971, on most systems. JEAN was a language special to ICL and was available nowhere else.

However as the computer system was set up in the University, BASIC caused a special problem to lay-users. There were a number of errors which when made resulted in a 'systems' response outside BASIC. This meant that the learners were required to identify this situation, remove the error and then get back into the BASIC system.

Another facility which JEAN has over BASIC is that it is very easy to run the program in parts. Thus from the point of view of the learners, the system was being built part by part. What is more the commands "DO PART 1" or "DELETE PART 3" etc., available in JEAN, related well with the description of various parts of a system under discussion. It may have been possible to write programs in BASIC which appeared to have responses similar to above but the resources, mainly development time and computer filing space, would have made it prohibitive.

For these reasons it was decided to use JEAN for the kits. However, an opportunity arose when it was thought that BASIC may be alright for one of the kits: "Programming a Computer". This kit included the following four topics:

(a) Programming a computer
(b) The computer programmer
(c) Presentation of output in various formats
(d) What can the computer not do.

The computer programs included were only 3/4 line ones. Also there were instructions for writing short programs. The teachers in the working
party were all excited about the kit and took it away for the initial

test. However in the following meeting the feedback they brought was

that the kit had failed completely with the learners. The main
difficulty was caused by the system taking over when a certain category
of error was made and had to be faced by all or most of the learners.
The expertise required to get out of the situation, in the opinion of
the trial teachers, was lacking in the learners. During a short dis­
cussion that followed it was obvious that training learners, even if it
was possible to do so (and there were some reservations on this as
well), would take them away from the main objective of the course, viz.
acquiring CA. This kit was therefore scrapped and various topics
covered in this kit were distributed in other kits as far as possible.

In terms of the assembly stage of tuning, what was found was that BASIC
as a component of the learning systems was incompatible with the other
components. To complete this argument it is not suggested that BASIC
is not suitable for any educational modules. Perhaps if the other
components covered, such as the age and ability ranges of the target
populations, were different or if the computer system was different
BASIC might have been adequate.

(iii) The Computer Programs

There was more control over the design of the computer programs than
over the two preceding elements. Almost all the programs were modified
during the tuning stages. Fine adjustments were made, mainly after the
assembly stage was completed, but during the construction of computer
programs it was always borne in mind that the programs have to be
compatible with the other components, and a careful eye was kept on
these programs during the formative evaluation of each kit.

Some of the features built into these kits are

(a) The parts of the programs matched with the parts of the systems
diagrams given. This meant programs sometimes became bulky and
occasionally there was duplication. In situations where the
programs did not allow for this a new program was provided when
instructions moved from one part to the next. For example, in
"Planning Routes for Fire Engines" there were three computer
programs, ROU1, ROU2 and ROUT. ROU1 was organised to deal with only a subset of the map and then only PART 1, PART 2 and PART 4. ROU2 dealt with the PART 3 and PART 4. ROUT dealt with the whole map as well as all facilities. The reason for separating the various activities in different programs was that if the learner made any errors in 'building' the data files of the system, it would not join up the whole program. Thus the learner's need (to 'build' the system a part at a time) carried more weight than to save filing space or to write elegant computer programs.

(b) The code used to call the programs from the computer file indicated the objective of the program and related well with the subject matter under discussion. Some of the codes for the computer programs are given below and the reader might like to check for himself that they relate to the subject matter in each kit.

**List of Sample Programs**

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</tr>
<tr>
<td>HIST</td>
<td>Historical Events</td>
</tr>
<tr>
<td>SQRE</td>
<td>Testing for squares of numbers</td>
</tr>
<tr>
<td>TEST</td>
<td>Test spellings, etc.</td>
</tr>
<tr>
<td>ROUT</td>
<td>Working out routes for fire engines</td>
</tr>
</tbody>
</table>

**Figure 6**

(c) One of the most rewarding activities during the development of this course was matching computing events with learning events. The standard approach to developing computer programs may be described as 'problem-solving using a computer'. In this the designer of a computer program may leap from the definition of the problem to computer programs or he may follow all or some of the following steps:
(a) problem as given in common language

(b) redefinition of the problem in quantitative form

(c) separating the problem in at least three parts:
   one - defining the processing involved, often
       one or more formulae
   two - defining the output and possibly its
       format
   three - defining the data required to solve the
       problem and its source.

(The reader is requested to note that this dissertation is not
about computer programs. The above procedure for writing computer
programs may apply to the simplest of problems, such as the
example given below. Some modern computer programs are very
sophisticated indeed and no pretence is made as to their
understanding even in principle. However the computer programs
designed for teaching ideally should have one additional element
in them, viz. that the computing events should match the
learning events.)

Take the example of the computer program for the kit "Planning
Routes for Fire Engines". A copy of these programs will be
found in the Appendix. The computer program ROUT has 17 parts
but only the first 4 parts relate to the four parts as seen in
the 'OUTLINE OF THE SYSTEM' by the learner. So far so good.
But because the learner is building the program one part at a
time for only a very tiny portion of the map to develop an
awareness of how the program is put together, he needs a special
program which allows him to do so. Computer program Rout 1
allows him to deal with Part 1, Part 2 and Part 3 for this
portion of the map. ROUT 2 then allows him to input special
hazards for this portion. These two programs still are complete
in accordance with the basic requirements of learning and allow
the learner to use the machine to work out the fastest route
for the given conditions. The full blooded program ROUT then
is used to experience the properties of the computer systems as
required for CA.
The computer program ROUT is "unprofessional" in the conventional sense. The "professional" program would have probably included a matrix for all the points on the map with facilities to input the distances between them and the various travelling times. It would have included only one format for the output giving the fastest time to the given point. This computer program would also have confused most of the learners as defined for this course.

The "unprofessional" program used is very bulky - Parts 5 to 17 as well as Forms 21 to 85 and 105 further lines are all data - and occupy a large space in the computer files but this program matches the learning events.

(iv) The Instructions

In a way the easiest part of assembling the course was writing the instructions in as much as there was more freedom in writing these instructions than in developing any of the other components. However, for the same reason, it was in the instructions that all the shortcomings of the other three components had to be compensated for.

Strictly from the point of view of the assembly, some of the features that were borne in mind were:

(a) The language clearly had to be such that the learners related to it.

(b) The instructions matched the computer programs.

(c) The diagrams matched the instructions and the computer programs.

(d) There were sufficient instructions to proceed with the operation, such as logging in and reaching a computer program.

There were others.

Interestingly enough some of the major innovations used in the instructions (such as a statement of what might have been learnt immediately following
the experience of the phenomenon) could have been left out during assembly without realising it. This would of course show up during the subsequent stages of tuning. Compare this with leaving out the vacuum tube from the carburettor and the advance mechanism of the distributor of a car. The car would start but during the road test it would show a lack of power.

Not much is said about the instructions here as this topic is adequately covered in the description of the learning material in Part II.

12.3 Testing for Assembly

If assembly is understood to mean a collection of matching components which are capable of operating together as a system, then all that was necessary to do was to check if the learners went through the 'motions' of carrying out the instructions without seeking too much help from agencies outside the system. It is of little interest to this stage of tuning whether the learners acquired any CA or not.

Most of the testing for the assembly stage was informal and involved observing the learners as part of the system in operation, followed by a quick check of the computer output. If the learner carried out most of the instructions (in practice all the instructions as they were sequential) without too much additional help it was assumed that the various components of the system matched.

Whether they matched adequately was discovered during the subsequent stages of tuning, and whether the learner had acquired any CA was discovered during the road test, i.e. the summative evaluation.

On the formal side of the formative evaluation the one quantity which could be measured on a large sample was the number of times the learners needed help. This and other formal parts of the feedback procedure and its results are discussed in chapter 14.

A Pilot Study was conducted during the early stages of this work and finished in September 1972. A copy is included with the rest of the supporting material. The reader may wish to thumb through it. Although
the original versions of the kits are quite different from the final versions the essential components as far as assembly is concerned are the same. In this respect the Pilot Study may be considered as a check that the components match. Please note that no measurement was made for 'the number of times help required' in this study. Awareness for the need for this measurement arose as a result of the Pilot Study.
CHAPTER 13

THE FORMATIVE EVALUATION: THE TUNING

13.1 INTRODUCTION

13.2 THE TUNING
13.1 Introduction

The fine tuning and the course tuning are carried out together as the distinction between them is too fine to put in practice. Most of the tuning had to be done informally. There were, however, some elements of feedback procedure which had a bearing on tuning. These, as well as the tuning procedures, are discussed in this chapter. Full discussion on feedback procedure takes place in chapter 14.

13.2 The Tuning

Once the system is operating the state of tuning may be assessed in two ways:

(i) Informally: by direct observation.
(ii) Formally: by measurement of various indices such as number of times help sought by the learner, as already mentioned.

(i) Direct Observation

In the case of a car engine one would adjust various controls until the engine runs smoothly and without misfiring. Clever mechanics can also assess the state of tuning by observing the lag between the engine speed increasing and the opening of the throttle. It is possible for an engine to run smoothly and yet fail this latter test. This is generally due to the ignition timing being too retarded. If the ignition timing is too advanced then the engine runs unevenly and develops other faults. The trick lies in making the adjustment so that the engine runs smoothly and yet passes the other test. There are indeed other elements to consider for motor car engines, but suffice it to say that tuning always involves balancing of various elements in a system so that the systems operation is optimum.
What are these elements as regards the learning system? And indeed what are the indicators for the level of tuning? During direct observation, if the learner was clearing his throat often or looked around the room or out of the window too often, one might conclude that the system was not operating smoothly. If he asked for interpretation of the instructions too often or sat too long doing nothing then one could assume that all was not well. One could ask the learner if he found the system interesting, one may get some useful response.

Based on the observation of learners using the materials, the following categories of adjustments were used:

(a) Ambiguous and misleading sentences in the instructions were changed.

(b) Excessive typing was eliminated.

(c) Instructions which went against what the learners tended to do at various stages were altered to accommodate the learners needs.

(d) The structure of computer programs was simplified, at least in those parts which the learners had to deal with directly.

(e) The diagrams of the Outline of the System was reorganised to suit the learners needs.

(f) Sample data was provided to learners every time it was required, even when the learners were given a choice to provide their own data. It was observed that when the learners were asked to provide their own data, which could be more or less any number from the top of their head, they sat there scratching it looking bewildered.

(g) Likewise, all the other supporting information was provided where and when it was needed, even if it had to be squeezing in.

After these and similar other adjustments were made so that the system operated smoothly, with long periods of learner concentration, it was
assumed that the tuning as far as possible by adjustments has been done. This, however, had to be confirmed further by more formal methods on a larger sample.

(ii) Formal Feedback

The instrument for formal feedback and the actual results are discussed in chapters 13 and 14. In so far as it is relevant to tuning it is included here. It will be false to pretend that the indices for measurement were primarily invented with tuning of the system in mind. On the contrary most of these indices existed and were used in the Institute for Educational Technology at the University of Surrey for a number of years before the author came across the feedback sheet used by the Institute. The author wishes to register his thanks to Will Bridge who originally designed and developed the sheet. The actual feedback sheet used by the author is a modification and is discussed in the next chapter. The only credit the author can take in this respect is that he realised that the self same indices could be used as measures for the level of tuning of the learning material. This feedback sheet will be found with other instruments of the measurement in the back pocket of this thesis.

Strictly as a measure of tuning the following information was collected:

(a) How difficult did the learner find a particular kit? The assumption is that if he found the kit too easy he will not care to go through it properly and if he found it too hard he will give up too easily. Indeed during the direct observation some learners did remark that the kit was too easy or too difficult. Ideally the mean should fall at 3 on a scale of 1 to 5. In the event the mean difficulty level turned out to be 2.4 for a sample of 243 learners. (See page 206).

(b) How interesting did the learner find the kit? Obviously if the learner found a kit boring his reaction will result in rendering the system of learning out of tune. Strictly from the point of view of tuning perhaps learners interest would be the most important single factor. The aim is to obtain a grade of 5 on the scale 1 to 5 for all learners for all kits.
In the event the mean interest level was 3.6. However, 65 did indicate their interest level to be 5 and only 9 indicated it to be 1.

(c) The number of times a learner asked for help clearly is the very indicator of the state of tuning of the system as already mentioned. Supervising teachers were asked to note the number of times the learners sought help during each trial. Ideally of course no learner would ask for help. In the event the mean level was 0.41 with 162 learners out of a total sample of 243 requiring no help at all and 68 requiring help once.
CHAPTER 14

THE FORMATIVE EVALUATION: THE FEEDBACK SHEET

14.1 INTRODUCTION 192

14.2 DEVELOPMENT OF THE FEEDBACK PROCEDURE 192

14.3 THE FEEDBACK SHEET 194
14.1 Introduction

The feedback procedure had two main aims:

(i) To confirm that the learning system was in a reasonable state of tuning as mentioned in the last chapter.

(ii) To collect factual information on the kits, such as time spent on carrying out the task set, etc.,

both for a larger sample than was possible during the informal phase of the tuning.

Initially the standard format of the general feedback sheet developed by the Institute of Educational Technology was used. As the development of the procedure took place the format, as well as the contents, were altered. However the essential spirit of the feedback sheet was maintained.

14.2 Development of the Feedback Procedure

The final design of the feedback sheet will be found in Appendix

An account is given of the development and rationale of this design in this section.

The instrument was developed with the help of the members of the working party representing nine institutions which were listed on page 117 in Chapter 5. These members were intimately involved with the feedback and evaluation procedures. The author wishes to acknowledge their invaluable help.

It was decided to obtain information from the learners on the following points:
(i) How many pages did the learner complete? If the learner did not complete the whole kit obviously there was something wrong.

(ii) How long did the learner take to complete the kit? If he took too long then the kit needed to be looked at again. If he took an absurdly short time then one may draw the conclusion that most probably the learner was not carrying out the instructions.

(iii) On a scale of 1 to 5 how difficult did the learner find the kit. It was generally accepted that if the learners found a kit too easy then they would lose interest in it and would probably not learn much from it, even if they went through the motions. If they found it too difficult obviously they would give up before completing the kit. It seems therefore that ideally the aim should be to obtain a grade of 3 on the scale 1 to 5 for all the learners, covering the age ranges 11 to 18 years and all ability ranges covered in the participating schools.

(iv) How interesting did the learners find the kit? They were asked to give a mark on the scale of 1 to 5. Again if the learners found the kit boring they were not going to learn much even if they went through the motions of completing all the instructions. Interest in the learning material should be generated in abundance, if the assumptions made about human learning were correct and if the learning method was applied effectively. In this ideally all learners should be fascinated with all the kits and give a score of 5 every time.

(v) How closely did the learners think each kit was related to the aim of the kit? The idea was that if the learners thought that they were asked to carry out instructions which had nothing to do with the aims of the course they would not be too keen to go through the activity.

(vi) It was considered of paramount importance to find out if there was any knowledge which the kits assumed but the learners did not possess. Since this could only be an open ended question they were to be given plenty of space to write down this information.
Likewise it was considered important to find out if the learners had any special difficulties in carrying out the instructions. Although it was assumed that most or all of the special difficulties should have been ironed out during the tuning stages of the learning system, it was necessary to obtain this information to confirm that this was so.

Finally space was to be provided for any other comments which the learners wished to make.

14.3 The Feedback Sheet

In the first version of the feedback sheet the information was sought in the following order:

(i) Name of the learner
(ii) Class
(iii) School
(iv) Name of the kit
(v) Difficulty level
(vi) Interest level
(vii) Relevance level
(viii) Number of pages completed
(ix) Time taken
(x) Assumption of previous knowledge
(xi) Any special difficulties
(xii) Any other comments

During the initial evaluation of the feedback sheet it was discovered that no children were filling in the spaces for the open ended questions (nos. x, xi and xii). It was felt that perhaps the learners felt that they had discharged their duty by filling in the quick response part of the sheet (nos. i to iv). It was therefore felt desirable to start the sheet with the questions on knowledge assumed and special difficulties, and follow these by the rest of the questions. This is the version of the sheet which was used for the Pilot Study.

During the trails for the Pilot Study there were still no entries to the open ended questions referred to above. Based on this feedback and on
some other considerations (given below) it was decided to redesign the feedback sheet. This redesign was minor in certain respects but quite important in certain others.

It was felt that, although the main objective of the feedback was to register the learners' reaction to the kits, those parts of the feedback which could be assessed by the supervisor should be so assessed. For example, if the learners sought help during a session on the computer terminal then clearly the supervisor was involved. Therefore when the feedback sheet was filled in why not let the supervisor fill in this information rather than the learner himself? It was felt that this would remove any uncertainty which might result if the learner put down a smaller figure than the true one, especially if he sought help many times. The number of times help was sought obviously can be measured 'objectively' and was therefore placed in the second part of the questionnaire to be filled in by the supervisor. (Please see the 'Final Design of Feedback Sheet' provided.)

It is possible that less literate learners had great difficulties in carrying out the prescribed work. Yet there were no comments on the sheets under this section, even when this was one of the first questions to be asked. Was it that those who had the greatest difficulty in operating the kit had least facility to express themselves in writing about their difficulties? (A poster advertising a course in learning to read can only have limited utility!). The supervisors were asked to assess if the learners did not have any knowledge assumed in a kit, as well as ask them at the end if they felt they did not have this knowledge. Likewise the supervisors assessed if the children had any difficulty with a kit. It was felt that if the learners had any such difficulties they would probably seek help from the supervisors. The supervisors were asked to fill in the blanks provided for this purpose in the feedback sheets. Thus the onus of determining and recording the number of times help was sought, any difficulties, and non-existent assumed knowledge and skills was shifted from the learners to the supervisors.

One other major amendment was made to the feedback sheet as it existed before. This concerned the question of relevance of the subject matter in the kits to the aims of the course. It was strongly felt that the learners not already possessing CA were hardly ideal people to judge if
the material was relevant to it. Later it was felt that this question could reasonably be assessed during summative evaluation. Initially it was assumed that if the learners did not feel they were carrying out an activity which was relevant to what they were supposed to learn about computers, they would not care about the material. It was felt that most probably, whether the children cared about the material or not would show up in their answers to questions on interest. If not it was decided to sacrifice this question as trying to explain to learners the aims of the kits may cause fresh problems. This question was therefore taken out of the feedback sheet.

Having got rid of the most awkward questions one way or another from the direct responsibility of the learners, it was easy to present them with the two main questions on the feedback sheet - one relating to the difficulty level and the other to the interest level. These questions were brought forward again at the start of the sheet after the learners had provided simple information about their name, date, etc. A well tried human scale of 1 to 5 was co-opted from the original IET document. A confirmation that a scale of 1 to 5 is the most refined scale that is practical came unexpectedly during the summative evaluation. This is discussed in a later section on page

It was decided to remove another question from the feedback sheet - that concerning the number of pages. It was found that all learners completed the whole kit every time. This question was therefore redundant.

One last question was left in tact - that concerning the time taken to complete a kit. It was to be filled in by the learners themselves. It may seem that all the arguments which led to the decision to get the supervisors to fill in the information about the number of times help was required apply to this question as well. In fact during the informal feedback stages the author discovered that some of the supervisors turned up with stop watches to measure this time and they did this overtly. It seemed that the learners were being entered for some kind of race against time, with the danger that all the educational objectives would be thrown overboard with one clean swoop! The question was therefore left for the learners to answer, without them being made aware of it before they completed the task set.
The supervisors were given another all important task. And that task was to get the learners to fill in their part of the questionnaire under supervision. The learners were read the questions and they were explained what each question meant and indeed what the scale of 1 to 5 was trying to measure. This way any doubt as to whether the learners understood the sentiments of the questions was minimised.

A few of the final design of the sheets were tried in field by the author and the other members of the Working Party. No difficulties were experienced and it was decided, during a meeting, to adopt this feedback sheet for the formal evaluation of the state of tuning of the learning system.
## CHAPTER 15

### THE FORMATIVE EVALUATION: THE RESULTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>15.1</td>
<td>INTRODUCTION</td>
<td>199</td>
</tr>
<tr>
<td>15.2</td>
<td>GENERAL</td>
<td>199</td>
</tr>
<tr>
<td>15.3</td>
<td>MAIN MEASUREMENTS</td>
<td></td>
</tr>
<tr>
<td>15.3.1</td>
<td>Number of Times Help Required</td>
<td>200</td>
</tr>
<tr>
<td>15.3.2</td>
<td>Time Taken to Complete a Kit</td>
<td>204</td>
</tr>
<tr>
<td>15.3.3</td>
<td>Difficulty Level</td>
<td>206</td>
</tr>
<tr>
<td>15.3.4</td>
<td>Interest Level</td>
<td>211</td>
</tr>
<tr>
<td>15.4</td>
<td>IS THE SYSTEM TUNED?</td>
<td>218</td>
</tr>
</tbody>
</table>
15.1 Introduction

The main objective of the feedback procedure were discussed in the preceding chapters. In any case, they are self-evident from the design of the sheet. However, there is additional information of general interest which simple analysis could yield. For example, how does the score in difficulty level compare with the score in interest level? This along with other similar information and the main results is given in this chapter.

15.2 General

Due to heavy dependence on the schools timetables and the other commitments of the teachers involved in the formative evaluation it was found difficult to distribute the sample evenly over schools, age ranges or the kits. Except in so far as it was necessary to obtain first hand experience during the development of the feedback sheets, the author did not involve himself with the filling in of the sheets with the learners in the schools. This was to avoid the author's own bias, possibly created by his interest in the success of the project, manifesting itself directly. Whereas bias of the supervising teachers was inevitable, it was felt that the net bias of the six or seven teachers involved was probably much less than that of the author himself. The distribution of the sample as it turned out is given below:

(a) Size of Sample: 243

(b) Distribution by Schools

<table>
<thead>
<tr>
<th>School</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>George Abbott</td>
<td>23</td>
</tr>
<tr>
<td>France Hill</td>
<td>95</td>
</tr>
<tr>
<td>Godalming College</td>
<td>24</td>
</tr>
<tr>
<td>Malmsbury</td>
<td>57</td>
</tr>
<tr>
<td>Sondes Place</td>
<td>44</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>243</td>
</tr>
</tbody>
</table>
(c) Distribution by Age

<table>
<thead>
<tr>
<th>Age</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>12 years</td>
<td>20</td>
</tr>
<tr>
<td>13 years</td>
<td>55</td>
</tr>
<tr>
<td>14 years</td>
<td>51</td>
</tr>
<tr>
<td>15 years</td>
<td>67</td>
</tr>
<tr>
<td>16 years</td>
<td>47</td>
</tr>
<tr>
<td>17 years</td>
<td>3</td>
</tr>
<tr>
<td>Total</td>
<td>243</td>
</tr>
</tbody>
</table>

(d) Distribution by Kit

<table>
<thead>
<tr>
<th>Kit</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction to Computer Terminal</td>
<td>92</td>
</tr>
<tr>
<td>Stock Control</td>
<td>40</td>
</tr>
<tr>
<td>Planning Routes for Fire Engines</td>
<td>39</td>
</tr>
<tr>
<td>Aid to Planning Committees</td>
<td>26</td>
</tr>
<tr>
<td>Aid in Education</td>
<td>46</td>
</tr>
<tr>
<td>Total</td>
<td>243</td>
</tr>
</tbody>
</table>

Although the above information is factual and does not require much comment, there are some interesting points to note. France Hill School was most active having provided 95 out of 243 samples, and George Abbott School was least active in that they provided only 23 samples. As indicated above no strict control was exercised on individual schools in providing guinea pigs as any feedback under duress must always be suspect. In fact another school which was very actively involved with the development of the material did not provide any feedback sheets at all.

It was lucky that the age distribution turned out to be reasonable except for the rather thin size of feedback from 17 year olds.

The distribution by kit does not seem to follow any pattern. 92 for the introductory kit, however, makes some sense. Having used a number of potential learners during the developmental stages of the material, the supervisors were hard put to find a large number of fresh learners who could be organised to go through a series of trials starting with the introductory kit. A lot of the learners therefore did only the first kit. It might be noted here that the whole of this sample was fresh in that they were not directly exposed to the kits before. In spite of this difficulty it can be seen that there is some feedback on all the kits involved - the
minimum number being 26 for the kit on 'Aid to Planning Committees'.

15.3 Main Measurements

15.3.1 Number of Times Help Required

Strictly from the point of view of tuning viz. smooth running, perhaps the most important single measurement was that concerned with the number of times the learners needed help during the operation of the kit. Obviously the material is not self-learning if the learners constantly cry for help. Before the formal feedback was carried out there were grave doubts as to whether the material would turn out to be self-learning for the broad ability and age ranges covered in the sample. On the other hand to expect that no learner would seek help ever was too much to hope for. The scores are given in Table 6.

<table>
<thead>
<tr>
<th>No of Times Help Sought</th>
<th>Absolute Frequency</th>
<th>Relative Frequency %</th>
<th>Cumulative Frequency %</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>162</td>
<td>66.7</td>
<td>66.7</td>
</tr>
<tr>
<td>1</td>
<td>68</td>
<td>28.0</td>
<td>94.7</td>
</tr>
<tr>
<td>2</td>
<td>10</td>
<td>4.1</td>
<td>98.8</td>
</tr>
<tr>
<td>3</td>
<td>2</td>
<td>0.8</td>
<td>99.6</td>
</tr>
<tr>
<td>6</td>
<td>1</td>
<td>0.4</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Mean = 0.6

Table 6

It may be noted that 66.7% did not ask for any help and that 94.7% asked for no help or only once. During the Working Party discussion it was agreed that helping the learners once during each session was acceptable as this did not amount to rendering the material non-self-learning. It is also worth noting that a kit went wrong drastically only once when a learner needed help six times.
It will be interesting to discover if the older learners sought help less number of times than the younger children. Cross-tabulation of the number of times help was sought by age is given in Table 7.
Number of Times Help-v-Age

<table>
<thead>
<tr>
<th>No of Times Help Sought</th>
<th>Age in Years</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>12</td>
</tr>
<tr>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>1</td>
<td>12</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>6</td>
<td>0</td>
</tr>
</tbody>
</table>

Mean for each Year Group: 0.8 0.55 0.37 0.34 0.26 0

Table 7

As can be seen, starting with a mean number of times help sought of 0.8 for 12 year olds, it drops steadily to 0.26 for 16 year olds. The sample of three for 17 year olds is too small to be significant.

The information is represented in Graph 3. It is obvious that the amount of help required reduced with rising age as should have been expected.

Mean Help-v-Age

Graph 3
15.3.2 Time Taken to Complete a Kit

The main objective of measuring the time taken to complete each kit was to ensure that the learners completed the kits within a period of double lessons, that is within the 70 minutes operating in Surrey schools. It is also of interest to discover if there were large numbers of learners who took too little time, say 10 minutes, or who took excessive time, say over an hour. Obviously those who took 10 minutes or so scarcely had time to learn much and those who took too long probably had great difficulties.

The scores are given in Table 8 below.

<table>
<thead>
<tr>
<th>Time in Minutes</th>
<th>Absolute Frequency</th>
<th>Relative Frequency %</th>
<th>Cumulative Frequency %</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>9</td>
<td>3.7</td>
<td>3.7</td>
</tr>
<tr>
<td>20</td>
<td>62</td>
<td>25.5</td>
<td>29.7</td>
</tr>
<tr>
<td>30</td>
<td>59</td>
<td>24.3</td>
<td>53.5</td>
</tr>
<tr>
<td>40</td>
<td>45</td>
<td>18.5</td>
<td>72.0</td>
</tr>
<tr>
<td>50</td>
<td>30</td>
<td>12.3</td>
<td>84.4</td>
</tr>
<tr>
<td>60</td>
<td>25</td>
<td>10.3</td>
<td>94.7</td>
</tr>
<tr>
<td>over 1 hour (= 70)</td>
<td>13</td>
<td>5.3</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Mean: 33 minutes

Table 8

As can be seen 94.7% completed a kit within one hour. Another interesting point to note is that 91% took between 20 and 60 minutes to complete a kit. This leaves 10% who either took too little or too long.

The mean time taken by each age group is given below.

<table>
<thead>
<tr>
<th>Age in Years</th>
<th>12</th>
<th>13</th>
<th>14</th>
<th>15</th>
<th>16</th>
<th>17</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean Time in Minutes</td>
<td>47.5</td>
<td>39.5</td>
<td>32.4</td>
<td>36.9</td>
<td>35.3</td>
<td>36.7</td>
</tr>
</tbody>
</table>

Table 9
It is interesting to note that the mean time taken to complete a kit drops sharply from 12 to 13 to 14 years old and then rises gently again. It is possible that the drop in the first leg of the graph is due to sheer mechanical facility in typing, reading, etc., and that about then the mechanical facility levels off but the interest level starts to increase. One effect of increasing interest is an increase in time taken to complete a kit. A graph relating mean interest score and time taken is reproduced here for this purpose. Otherwise this graph is quite out of place here and is dealt with elsewhere again (page 214).

**Mean Interest Level-v-Age**
15.3.3 Difficulty Level

The reader will remember that the basic philosophy behind scoring difficulty levels on a scale of 1 to 5 was that ideally the learner should experience a difficulty level of 3, so that he did not think that the learning material was either too trivial for him to bother about or too difficult for him to complete the prescribed task. The difficulty scores are given in Table 10.

### Difficulty Level

<table>
<thead>
<tr>
<th>Difficulty Level</th>
<th>Absolute Frequency</th>
<th>Relative Frequency %</th>
<th>Cumulative Frequency %</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>37</td>
<td>15.2</td>
<td>15.2</td>
</tr>
<tr>
<td>2</td>
<td>75</td>
<td>30.9</td>
<td>46.1</td>
</tr>
<tr>
<td>3</td>
<td>117</td>
<td>48.1</td>
<td>94.2</td>
</tr>
<tr>
<td>4</td>
<td>14</td>
<td>5.8</td>
<td>100.0</td>
</tr>
<tr>
<td>5</td>
<td>0</td>
<td>0.0</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Mean: 2.4

**Table 10**

This information is represented in graphical form in Graph 6.
There are several points to note in this set of scores.

(i) The mean score is 2.4 which is encouraging but perhaps not ideal. The fact that nobody scored 5 has obviously influenced the mean. It is too good to be true that no learner, including the least able 12 year olds, thought that a kit was too difficult. It is nice to be able to believe that no kit was actually too difficult for anybody. However, it is possible that no learner wanted to admit that a kit was too difficult, no matter how difficult he found it. At the same time all the learners did complete the kits in this sample. Therefore there is at least this consolation that no learner gave up trying because he thought it was too difficult.

If the score of 5 is ignored, i.e. if it is assumed that the effective scale was 1 to 4 then the mean score of 2.4 is very nearly dead in the middle, which is what could have been hoped for but not expected.

(ii) 79% of the sample scored either 2 or 3 for their difficulty level. 15% thought it was too easy and 6% gave a score of 4 for difficulty on the scale of 1 to 5.

(iii) 94.2% found the difficulty level of 3 or less and of course all found the difficulty level of 4 or less. The one worrying score is that 15.2% found the kits very easy. It might be thought that there is an age group who found the kits too easy. For this reason and for general interest a cross-tabulation of difficulty by age is given in Table

<table>
<thead>
<tr>
<th>Difficulty Level</th>
<th>Age in Years</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>12</td>
</tr>
<tr>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>7</td>
</tr>
<tr>
<td>3</td>
<td>8</td>
</tr>
<tr>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Mean for each Year Group</td>
<td>2.5</td>
</tr>
</tbody>
</table>

Table 11
Difficulty level (mean) v age is represented in Graph 7.

The distribution of age for the score of 1 (too easy) as percentage of sample in each year group is:

% of Sample Scoring 1 for Difficulty-v-Age

<table>
<thead>
<tr>
<th>Age in Years</th>
<th>12</th>
<th>13</th>
<th>14</th>
<th>15</th>
<th>16</th>
<th>17</th>
</tr>
</thead>
<tbody>
<tr>
<td>% of Sample Scoring 1 in each Year</td>
<td>15%</td>
<td>10.9%</td>
<td>7.8%</td>
<td>20.9%</td>
<td>21.3%</td>
<td>0%</td>
</tr>
</tbody>
</table>

Table 12

Ignoring the 12 year olds for a moment, it is obvious that 15 and 16 year olds had a much higher score of 1 than others. The sample for 17 year olds is too small (5) to be of any significance. However, 12 year olds had 15% scoring 1, higher than 13 and 14 year olds and this looks puzzling. It is possible that 12 year olds went through the motions of carrying out the instructions without perhaps coming to grips with the higher concepts of CA. In spite of that 50% of the 12 year olds scored an interest level of 5 (see Table 5, page 211) and this is discussed further shortly. It is encouraging to note that the mean difficulty level experienced by various age groups is comparable. Once again the sample for 17 year olds is too small to be significant.
(iv) The breakdown of difficulty level scored for each kit is given in Table 13.

**Difficulty Level - by Kit**

<table>
<thead>
<tr>
<th>Difficulty Level</th>
<th>Introduction to Terminal</th>
<th>Stock Control</th>
<th>Aid to Education</th>
<th>Fire Engine</th>
<th>Aid to Planning</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3</td>
<td>13</td>
<td>12</td>
<td>9</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>14</td>
<td>30</td>
<td>10</td>
<td>15</td>
<td>6</td>
</tr>
<tr>
<td>3</td>
<td>16</td>
<td>46</td>
<td>24</td>
<td>14</td>
<td>17</td>
</tr>
<tr>
<td>4</td>
<td>7</td>
<td>3</td>
<td>0</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Mean Difficulty Level</td>
<td>2.7</td>
<td>2.4</td>
<td>2.3</td>
<td>2.2</td>
<td>2.8</td>
</tr>
</tbody>
</table>

Table 13

There is good confirmation that the learners found a similar level of difficulty with the various kits. The kits 'Stock Control' and 'Aid to Planning' had a lot of work in them and were quite complex, so slightly higher scores for them are no surprise. Likewise 'Education' was comparatively simple, so a low score of 2.3 is justifiable. The surprising result is the low score of 2.2 for the kit on 'Fire Engines' as this kit was complex and long. The only explanation could have been that the learners found this kit especially interesting and therefore 'felt' less difficulty than would have been the case otherwise. But the facts do not bear this out as the mean interest score for this kit is 3.4 as against the overall mean of 3.6 (see Table 15, page 211).

(v) A cross-tabulation of difficulty by time taken to complete a kit is given in Table 14.
There is clearly a high correlation between the time taken to complete a kit and the difficulty level scored. These results are plotted in Graph 8 below. It can be seen that the progression forms a regular pattern.
(vi) A cross-tabulation of difficulty by interest scores is discussed at the end of the next sub-section on interest on page 15.3.4

Interest Level

(i) The scores for interest level for the whole sample are given in Table 15 and in Graph 9.

<table>
<thead>
<tr>
<th>Interest Level</th>
<th>Absolute Frequency</th>
<th>Relative Frequency %</th>
<th>Cumulative Frequency %</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>65</td>
<td>26.7</td>
<td>26.7</td>
</tr>
<tr>
<td>4</td>
<td>73</td>
<td>30.0</td>
<td>56.7</td>
</tr>
<tr>
<td>3</td>
<td>57</td>
<td>23.5</td>
<td>80.2</td>
</tr>
<tr>
<td>2</td>
<td>39</td>
<td>16.0</td>
<td>96.3</td>
</tr>
<tr>
<td>1</td>
<td>9</td>
<td>3.7</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Mean: 3.6

Table 15

Graph 9
The result in the table is given in decreasing level of interest as cumulative frequency makes sense this way only. As can be seen 96.3% level of 3 or more. Only 9 out of a sample of 243 scored 'very boring'. The mean is 3.6.

(ii) A cross-tabulation of interest level by age is given in Table 16.

<table>
<thead>
<tr>
<th>Interest Level</th>
<th>Age in Years</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>12</td>
</tr>
<tr>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>Mean Interest Level</td>
<td>3.95</td>
</tr>
</tbody>
</table>

Table 16

Mean interest level scores v age is represented in the graph below.
The mean interest level drops to a minimum for age 15 though even then it is 3.12. This graph adds to the intuitive explanation given on page 205 while discussing time v age figures that the interest level probably has something to do with time taken to complete a kit. The scheme seems to be that the interest level first drops with age and then at about 14 or 15 years it starts rising. Since the time taken to complete a kit also follows the same general pattern, it seems that the time taken to complete a kit rises with increasing interest level. This is a slightly surprising result as it was suspected that more boring a kit is found by a learner the more time he will take to complete it. However, a cross-tabulation of interest v time is called for and is given in Table 17.

### Interest Level-v-Time

<table>
<thead>
<tr>
<th>Interest Level</th>
<th>Time in Minutes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>10</td>
</tr>
<tr>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>Mean Interest</td>
<td>1.89</td>
</tr>
</tbody>
</table>

Table 17

To make sense of the figures for mean interest level scored for each time interval which seems to confirm the above hypothesis, they are represented in the Graph 11.
Happily this graph confirms that by and large the time taken to complete a kit rises with interest. Also it is almost a straight line from 20 minutes to 60 minutes. There is a sharp rise from 10 minutes to 20 minutes in the interest level and of course there is a drop from 60 minutes to 70 minutes. The explanation seems to be that anybody who can complete a kit in 10 minutes can hardly have time to be interested in it. Also if it is taking longer than one hour it must be a drag. However, further investigation is required to generalise the definition of the conditions which determine the limits to the linear relationship between interest and time taken to complete a learning task in cognitive terms.

(iii) It is all very well to obtain a high mean interest score over the five kits. But it should not be enough if there are some kits for which the mean interest level is low. Ideally, of course, the mean interest score should be comparable for each individual kit. A cross-tabulation of interest score v kit is given in Table 18.
<table>
<thead>
<tr>
<th>Interest Level</th>
<th>Introduction to Terminal</th>
<th>Stock Control</th>
<th>Aid to Education</th>
<th>Fire Engine</th>
<th>Aid to Planning</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0</td>
<td>6</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>7</td>
<td>10</td>
<td>13</td>
<td>7</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>14</td>
<td>13</td>
<td>8</td>
<td>12</td>
<td>10</td>
</tr>
<tr>
<td>4</td>
<td>9</td>
<td>32</td>
<td>14</td>
<td>12</td>
<td>6</td>
</tr>
<tr>
<td>5</td>
<td>10</td>
<td>31</td>
<td>10</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>Mean Interest Score</td>
<td>3.8</td>
<td>3.8</td>
<td>3.4</td>
<td>3.4</td>
<td>3.6</td>
</tr>
</tbody>
</table>

Table 18

As can be seen the mean interest level for each kit is comparable and the spread is very small. In terms of tuning one might state that each of the five components of the dynamic learning system is generating the same amount of interest for the learners.

(iv) It is necessary to check the relationship between the interest score and the difficulty score to confirm the hypothesis that to sustain maximum interest the learning task should neither be too easy nor too difficult. This cannot be easily done as it needs three dimensional representation. For this an obvious starting point is a cross-tabulation of interest score v difficulty score. This is given in Table 19.
<table>
<thead>
<tr>
<th>Interest Score</th>
<th>Difficulty Score</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>2</td>
<td>13</td>
</tr>
<tr>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>Mean Interest Score</td>
<td>3.19</td>
</tr>
</tbody>
</table>

Table 19

On the face of it the mean interest score seems to bear out the hypothesis. It rises steadily to difficulty level 3 and falls for difficulty level 4 as can be seen in Graph 12.

*Interest-v-Difficulty*
However, it is possible to represent the whole matrix (not only the mean interest score) in three dimensions by drawing a steriogram. The whole objective of this representation is the visual impact it makes. Since the steriograms do not have perspective they can cause visual disturbance. The author has developed a technique to represent steriograms in perspective and they have been christened "Sterographic Histograms". One of these representing interest score v difficulty score is given here:
A 'hump' may be discovered around the interest level of 3 and 4, and difficulty level of 3, thus confirming the hypothesis being tested. It is unfortunate that the columns for difficulty level 4 for interest levels of 4 and 5 are hidden, but they can easily be checked as representing frequency of 3 each from the table. The only unexplainable reading is the frequency of 13 for difficulty level 1 and interest level 2.

15.4 Is the System Tuned?

Clearly a judgement whether the system is tuned or not can only be made on the whole of the findings given in the previous section. But based on the following summary of the findings:

(i) Mean number of times help required: 0.4
(ii) Mean time taken to complete a kit: 3.3 minutes
(iii) Mean difficulty level on scale 1 to 5: 2.4
(iv) Mean interest level on scale 1 to 5: 3.6
(v) Mean of number of times help required, mean of difficulty level and mean of interest level is comparable for various kits over each age group,

one may come to the conclusion that the learning system is reasonably tuned.
# CHAPTER 16

THE SUMMATIVE EVALUATION: THE OBJECTIVES AND PROCEDURES

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<td>Open-ended Interviews</td>
<td>224</td>
</tr>
</tbody>
</table>
16.1 The Non-objectives

One of the easiest traps to fall into is to evaluate the contents of an educational material by criteria based on the contents themselves thus bypassing the objectives completely unless the objectives are defined by the contents. Thus if an objective of a course is the application of, say, algebraic equations in engineering and the entire evaluation concerns itself with the solution of quadratic equations, then the evaluation cannot be said to be valid.

The author did fall into this trap during the Pilot Study. The first evaluation of the kits was a written test based entirely on the contents of the kits. This procedure tested the memory and other abilities of the learners and evaluated the kits to meet the stated objective of the kits only marginally if at all. For example, the question "How many parts is the system divided into?" has little bearing on CA. Marginally, the fact that it is possible to look at a computer program as being made up of parts perhaps, but the number of parts the programs are divided into is arbitrary and was mainly determined by the various assumptions made about learning. It is easy too, to test the learners on their remembering the CA statements. However this left out their application in real life situations which is what this evaluation should have been all about.

To make matters worse the results were good (67% scored 67% or more) considering that they were for all ability and age ranges. The members of the Working Party as well as the author were all quite happy until it dawned on them that this testing had nothing to do with CA.

Another look at the stated objectives of the main part of the course i.e. the kits other than "Introduction to the Computer Terminal" was clearly called for. To refresh the readers memory they were:

1 Learners will experience a number of computer applications.
2 Learners will experience properties of computers relevant to CA. (see Chapter 7 page 127)
Once again it would not have been difficult to demonstrate that the kits met these objectives provided that the learners actually carried out the task prescribed in the kits. There was ample evidence from the feedback that they had done so. A further survey and analysis might have indicated if these objectives had been adequately met. Assuming that this was the case, does it mean that the learners had actually acquired CA? Although an involved and lengthy argument was given in Chapter 1 relating CA with knowledge of applications and properties of computer systems, the objective of summative evaluation must be to confirm or reject that this relationship exists. The objective of the whole course may be defined briefly as, "Learners will acquire computer awareness as a result of carrying out the prescribed task." This objective is evaluated directly by a procedure to evaluate the objectives mentioned in the last paragraph. Attractive though this alternative was for ease of implementation, this line of thought was not pursued any further.

16.2 The Objective

The crux of the matter seems to lie in the definition of CA. For the last time the reader is subjected to this definition perforce:

Computer Awareness is taken to be the possession of sufficient knowledge to enable inferences, general and social, to be made on the basis of what is seen or heard about computers.

The objective of the evaluation therefore is to determine if the learners, after they have gone through the course, are able to make inferences on the basis of what is seen or heard about computers, by implication in real life. This clearly requires a transfer test rather than a direct one (Hartley, 1972). The main advantage of this approach is that it evaluates everything said in this thesis, the assumptions made about specific situation and indeed, the learning material, with one clean swoop. The main disadvantage of this approach is that it is extremely difficult to measure the quality of inferences made in quantitative terms to make a sensible judgement. A further disadvantage is that if the objective is to be met squarely then the evaluation must take place in real life situations. In spite of these formidable difficulties it was
decided, in conjunction with the participating teachers, to try out this approach. The results were full of surprises but valid.

16.3 The Alternative Procedures

Various procedures for summative evaluation are appraised below:

16.3.1 The Written Test

One of the easiest methods of evaluation is to set a written test; the results provide a measure of success or failure of the educational material. There are three main types of question that can be given in the written tests:

(i) Multiple choice. For example:

"If you are presented with a computer printed Gas bill which seems excessive to you, which of the following alternatives will you chose as a starting point?:

A Blame the computer
B Telephone the Gas Board
C Check the meter reading
D Check the calculation on the bill
E Check if there is a gas leak."

(ii) Descriptive questions. For example:

"Enumerate the main advantages and disadvantages of using computers to process information as against human beings."

(iii) Essay. For example:

"Write an essay describing the uses and abuses of computers."

(iv) Description of a real life situation involving computers, asking learners to draw inferences from it.
All written tests demand a certain amount of literacy and comprehension to understand the questions and some fluency in written expression to answer them. This of course applies minimally to the multiple choice questions, but in this case the depth achieved is limited. This type of question is ideally suited to factual information such as historical dates or for one step deductions such as the decimal equivalent of a fraction. Inferences generally can only be assumed and opinions can never be right or wrong, only informed or uninformed. The descriptive questions demand a high degree of organisation and some ability to memorise. Both these factors may be assumed for acquisition of CA but should replace it. Once again, in the example given, what is an advantage of using a computer for one man may be a disadvantage for another, both having good reasoning behind their attitude. This in fact is the main component of CA: the reasoning behind opinions, attitudes and reactions.

The essay type of open ended answer can meet this requirement but only for those who have mastered the art of essay writing. Some possess a high degree of general awareness and are capable of making first rate decisions but are poor essay writers.

Description of any real life situation is lengthy. This method assumes a high degree of motivation on the part of the learner - a pitfall which was avoided in the development of the material at great pains.

To sum up: written questions were ruled out because either they were too shallow or they measured abilities other than to CA.

16.3.2 Learners reaction to films depicting situations with computers

One interesting idea considered was to show a film depicting a real life situation followed by the learners giving their reaction either in writing or verbally when they would be recorded by, say, a teacher.

Appraisal: This method, in principle, seems to be promising. The films could either be "lifted" from existing collections and edited to suit this purpose or they could be developed especially. A telephone call
followed by a letter to the BBC soon showed that, in addition to the very long red tape surrounding the BBC archives there was another lengthy process involved in discovering the right material. One had to go through the archives systematically, after permission was granted, reading tons of scripts to discover any suitable film. The estimated time for this was 18 months. This seemed like a full blooded research project in its own right.

The other alternative of producing films was also time-consuming - and in addition was expensive. This alternative had to be rejected on the amount of resource required alone.

16.3.3 Fully Structured Interviews

One common practice in social survey is to design a detailed questionnaire which is then presented to the subject verbally and the interviewer then fills in the questionnaire herself. This overcomes most of the objections to written tests. One difficulty however remains, which is that this procedure does not allow for lengthy reasons for an attitude or opinion to be recorded. This procedure also requires a certain amount of training of the interviewers.

16.3.4 Open-ended Interviews

The method which finally seemed most likely was partially structured and open-ended interviews. This allowed for a certain number of questions to be included which would form the common core for all the interviews and yet permitted pursuit of some arguments at length, bringing to the surface the "informed" part of the informed opinion of the learners.

The difficulty of recording everything said, however, still remained. It seemed at this stage that the need to record the interview could be eliminated if the assessment of the level of CA was made immediately. This approach will have dubious reliability, especially if more than one interviewer is involved. It is time consuming as only one interview can be handled at the time. To produce a decent sized sample there would have to be more than one interviewer. There is also a major problem with the standards to be adopted as there is no existing
standardised measure for assessing awareness; and indeed there is
the further problem of scaling - what criteria can be used for
validating this or any other procedure for assessing awareness?

In spite of all these difficulties, this is the method which was
decided upon unanimously by the Working Party members, who eventually
also went through a rigorous programme of training and acted as the
interviewers.

Full justification for adopting this method, as well as how an attempt
was made to overcome the difficulties is described in the next chapter,
entitled, "The Instrument of Measurement".
CHAPTER 17

THE SUMMATIVE EVALUATION: THE INSTRUMENT OF MEASUREMENT

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CHAPTER 17

THE SUMMATIVE EVALUATION: THE INSTRUMENT OF MEASUREMENT

17.1 Introduction

Instead of giving a historical account of the development of the instrument of measurement, the instrument is first defined followed by the rationale, procedures for validation, etc.

The final instrument took the form of a single interview whose structure allowed for assessment of general awareness and computer awareness possessed by the learners, and their comparison. The results, if the interview turned out to be valid, were given as a grade of CA as compared to GA (general awareness) on a scale of -3 to +3 thus eliminating the necessity of defining an absolute scale for CA.

17.2 The Definition

In the appendix the reader will find a collection under the heading 'Summative Evaluation'. What follows now will refer to this from time to time. A few bold statements are given now which can make full sense only in the light of the explanations which follow. The author apologises to the reader for this process which is a reversal of what has been practiced in this thesis so far. It was difficult enough to develop the procedure but to present the account of it in a logical manner is beyond the capabilities of the author - he accepts failure in this one respect.

The Objective Redefined

The Instrument of Measurement for levels of computer awareness will directly read the differential between the levels of computer awareness and general awareness possessed by the Subject at the time of measurement.

The Instrument

The instrument itself has the following ingredients.
A semi-structured interview which includes a predetermined content, and allows for a free run of discussion based on the subject's interests, skills, inhibitions, facilities, etc., in the general field of Awareness: computer or otherwise.

A document for the interviewers listing a number of situations relevant to CA and GA to be presented verbally to the subject forming the common core of all the interviews.

A validation sheet with a comprehensive procedure to validate each interview separately.

An assessment sheet which first determines whether CA=GA or CA>GA or CA<GA and then if CA≠GA then on a scale of 1,2,3 on comparison between CA and GA.

The all important interviewer who has gone through a process of training as one of a group to reach a minimum level of reliability i.e. the reading for CA-V-GA he or she registers for an interview has a high correspondence with the reading registered by the group as a whole for the same interviews.

17.3 Rationale and Development

An account is given now of the development of the Instrument.

17.3.1 The Guidelines for the Interviews

During the trial interviews with the subjects which the author conducted himself, it became obvious that to discover the level of awareness effectively it was necessary to give all the S's a free run to pursue a line of thought about anything that caught their fancy at that particular moment. One S had an obsession with classical music and was able to talk in depth about it and some musical instruments. Another S was most annoyed that the Doctors' were not being paid enough and were forced to

*Note: In practice the validation sheet and assessment sheet was a single piece of paper identified by CAA(K) on the top right hand corner.
consider industrial action like 'common' union members. One young lady of 12 years had just come back after spending a year in Australia and was most upset with the way the male chauvinists there treated their women. Whereas strong opinions expressed did not, by themselves, amount to a high degree of awareness, it was only when the S's had a chance to discuss them that it was possible to assess the degree to which their opinions were in fact informed. This information was presented to the Working Party members. It was agreed that interviews should have an element of "free run" and from this point of view they should not be fully structured.

Apart from discovering that the S's 'exposed' knowledge base best when they were talking about a matter of special interest to them at that moment, it also became obvious that most of the S's would not be capable of developing an equivalent argument in writing. This supported an earlier decision that an essay type of test was not suitable for the present purpose. In addition it was clear that the S's reacted to the verbal prompting to "speak their mind" which probably would not be the case if it was just a question of writing an essay.

Reverting to the main issue of the interviews, the members of the Working Party felt that a "free run" interview was not enough by itself - that there first had to be a common element in all interviews, so that there is a certain amount of consistency. This lead to the decision to agree on a list of topics which dealt with situations to bring out the elements of GA and CA. This document will be found along with others under "Summative Evaluation" in the Appendix.

The list consists of a number of situations dealing with GA and separately with CA. It is meant as a guidance in the sense that after the first question is asked, then the follow on question must relate to the response and therefore cannot be completely determined. As can be seen at all stages the S's are encouraged to give reasons for their opinions. However, if instead of gently guiding the S to explore his reasoning behind his own opinion, he is bullied into defending his opinions, a conflict between the interviewer and the S may result and any conclusions arrived at by the interviewer must be suspect. This problem and others that may arise are discussed later along with the solutions adopted.
The situation covered included political, economic, travel, high technology, environment, food and hobbies as aspects of GA. It was not expected that all the situations would be covered in detail. The idea was to provide sufficient variety of situation to maximise the changes of S's going into a detailed discussion on one or two of them. Although topics on high technology (e.g. Concorde) was included, it was the awareness aspect which was of interest and not the technical information. It was also agreed that whilst discussing aspects of GA if the question of computers cropped up naturally the interviewer should cash in on it rather than artificially postpone it to the later part of the interview. In fact it was agreed that as far as possible the boundary between the two parts of the interview should be as hazy as possible.

The CA discussion was started by talking to the S's about their envisaged careers. The chances were that it would not be difficult to guide the discussion towards computers as most careers involve them directly or indirectly. Apart from computers in careers, the other aspect of CA included were computers in social services, Personal Data Banks, and comparison between humans and computers as far as information processing is concerned. The special applications such as real time computing and computer models etc., were not included precisely for the same reasons for not including them in the contents of the kits (see page 143).

Just in case the reader has lost track of the subject of the present discussion: it is that the interviews were partially structured to provide a common core, and open-ended to allow the S's to pursue any argument according to their abilities. This way it was expected that both the areas, that of GA as well as CA, would be adequately explored.

### 17.3.2 The Measurement of Levels of CA

Having agreed upon the general nature of the interview a method has to be determined to measure the level of CA. It is a fact of life that education has not considered 'awareness' as a legitimate objective for formal training. At best it is assumed that an educated person should be generally aware of what goes on around him. By implication it means that a person will pick up 'awareness' incidentally as he goes through
It is not surprising that no procedures have been developed to measure the levels of awareness possessed by an individual. A generally accepted scale which may be adopted does not exist. Creation of a scale for measurement of something as novel as levels of 'computer awareness' must meet two major requirements and a number of subsidiary ones. First the scale must relate to some other standard which can be demonstrated to be valid. Second the scale must be fine enough to give a meaningful measurement on one hand and is not too fine for the instrument of measurement on the other.

The obvious comparable quantity to levels of computer awareness is the level of general awareness possessed by the subject. Remembering that the present educational objective always applies to the social context, one may think of GA operationally, as the demonstration of a person's capability to deal with common situations. The ideal approach to measure the levels of GA therefore seems to be to place a person in real life situations and devise a means of measuring his performance. This can then be developed into measurement of CA. However this process is almost impossible in practice as it would take a very long time to determine the levels possessed by even a single S. The alternative seems to be to assess the level of GA possessed by a person during an interview and use the same procedure for assessing the level of CA. This way one may make a decision that the S possesses such an such a level of CA compared to his level of GA or even compared of the mean level of GA as possessed by the sample as a whole. It is suggested that a statement like "this person possesses a level of four for CA compared to his level of three or five for GA on a scale of one to ten" is more easily understandable than a statement "this person possesses a level of eighteen for CA on a scale of one to twenty" for example. This method does involve measurement of two quantities but this seems to be the only way to make the results sensible.

On the question of actual scale an original scale of one to twenty was tried. The members of the Working Party listened to a recorded tape of an interview with a learner, and were asked to put down a mark for the level of GA. Even before they actually wrote down their assessment, most of the members voiced the opinion that the scale is too fine for them to make a judgement. The scale was then reduced to one to ten, with similar consequences. It seemed that the well established scale
of one to five is the one to adopt - and it worked. The whole
procedure for interviewer training and establishing the final scale
is given in section 17.3 with the actual results.

Next question to be answered is as to which of the two procedures for
actual comparison of the two levels of awarenesses should be adopted.
Should the level of GA and CA be determined separately on what would
be absolute scale of one to five for each and then the two quantities
compared or should the differential between the levels be determined
directly during a single interview with an S.

To answer this question one may start with some common and some not so
common human experience. To assess how warm is the water in a cup one
may dip a finger in it and say this water is luke warm, that is if the
instrument of measurement is not destroyed in the process because the
water was boiling hot. If one wants to compare the hotness (temperature
is too fine a word for this present situation) of water in two cups, one
may try dipping two separate fingers in the two cups. If the differential
is large, one may easily determine which is the hotter of the two. But
if the differential is small the two finger approach will fail - certainly
if the differential is reduced gradually a time will come when this
method will not work. However what may be called the one finger approach
has more promise. Dip a finger in one cup first and immediately in the
other, and soon it will be obvious which of the two cups hold hotter
water. So one judgement as to how the level of hotness in cup A compares
with the level of hotness in cup B i.e. is hotter, colder or the same can
be made immediately depending upon the sensitivity of the instrument
of measurement - the finger. In case the reader has not noticed it him­
self, this gives a scale of one to three without much difficulty. If
the differential for a given experiment is found to be nil i.e. if it is
assessed that the two liquids are equally hot then that is as far as the
existing measurement can go. However if a differential is detected then
one may try refining the scale a bit more. If the water in cup A is
hotter than the water in cup B then one may ask how much hotter say on a
scale of one to three, which it is assumed is within human capability.
If the same scale of one to three is applied to the reverse situation
i.e. when the water in A is colder than water in B, then effectively a
seven point scale is created thus:
This scale may be redrawn to eliminate the words hotter and colder as

Thus this scale will read 0 when A=B, minus for when A<B and plus for A>B. If a scale of one to seven is given, then reading will always be positive even when A is colder than B, which may prove confusing when the reading is given as an abstract.

The facility which this approach provides in carrying out the comparisons is at the cost of not providing any information about the measure of either A or B on some absolute scale. The reasons for deciding to pay this cost is given towards the end of this section.

There are many examples which indicate that this procedure is more accurate than that employing absolute measurements in science and technology. The most elegant of them all is the beam balance. Compare the determination of the mass of an object by a spring balance or by a spring balance. Say the true mass of the object is five units. Also assume that the two balances give an error of 10%. The spring balance will give a reading of 5±0.5 units. If the mass whose beam balance against which the comparison is being taken is say 4.9 units then the differential between the two is 0.1 units. The reading therefore will be 5±0.01 units i.e. it will be out by 10% of the differential. The error of the spring balance is 50 times the error of the beam balance. In practice of course the spring balances can be made quite accurate, but if the same precision in design and manufacture is applied to both the balances, the beam balance will invariably be more accurate. This is due to the inherent nature of the two processes.

Reverting to the levels of CA and GA there is another argument whey a comparison is preferred to some absolute measurement. The level of GA possessed by a learner defines his capability for acquiring awareness.
A person who has a greater propensity for acquiring awareness will do better in a course for computer awareness than a person who has less capability in the field. Normally for evaluating a module of education say in mathematics, one defines the sample according to their performance previously in mathematics. Some test results or teachers assessment of the learners standard of achievement provides a guideline. Often the module is specifically designed for a narrow band of ability and age ranges. In any case there is no course which will deliver the same amount of education to each and every learner ignoring the individual differences. The advantage of adopting the procedure for comparison is that it takes into account the individual differences. In this course it may be assumed that the spread of abilities is very large as it takes in all ages and ability ranges in Surrey schools. The evaluation results will show how far the S has been able to acquire CA taking into account his standards relating to the general area of awareness.

17.3.3 The Objective of the Evaluation

In the light of the foregoing the more precise definition of the objective for evaluation may be attempted. As a first approximation it should read something like this: the learners will acquire CA to the same level as that they possess in GA as a result of carrying out the procedures prescribed in the course.

As the reader will no doubt remember, in early chapters whilst developing the concept of computer awareness, it was suggested that a general course for all needs to be developed which will bring the awareness about computers on par with their general awareness. Therefore formally the objective for this course can only aspire to bring the level for CA to the existing level of GA in the learner. Formally, that is, the loftier objective of making everybody deal with situations involving computers with some kind of special understanding is not part of this course. In practice, however, since CA is being taught, instead of being acquired incidentally like GA; it should be acquired to a slightly higher level.

Two more aspects of the above objective have to be included to complete its definition. The first is the original definition of CA. The reader
will not be subjected to this definition in its raw form yet again - instead the objective for evaluation incorporating this is given: the learners will possess sufficient knowledge to make social and general inferences on the basis of what he sees or hears about computers with the same facility as he does on the basis of what he sees or hears about situations not involving computers, as a result of carrying out the procedures prescribed in the course.

Of necessity this definition has to be lengthy and involved as it must include all the salient features of what is being defined. This gets worse as it is modified to define the objective of evaluation and includes the second aspect of the objective, that relating to the scale.

The final definition of evaluation for a course in Computer Awareness is as follows

This evaluation procedure will determine the level of facility to make social and general inferences on the basis of what the learner sees or hears about computers as compared to his level of facility to make inferences on the basis of what he sees or hears about situations not involving computers, possessed by him if he carries out the procedures prescribed in the course on Computer Awareness, on the scale:

<table>
<thead>
<tr>
<th>CA very much less than GA</th>
<th>CA=GA</th>
<th>CA very much greater than GA</th>
</tr>
</thead>
<tbody>
<tr>
<td>-3, -2, -1, 0, +1, +2, +3</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The evaluation as defined above can now be said to be valid i.e. it will evaluate CA as originally defined provided it meets the stated requirements on the grounds that it is self-evident. Hartley (1972) defines the test as 'valid if it measures what it purports to measure'. However the validity of each interview is another matter and discussed in the next section.
During the trial interviews held by the author with some S's there were some subjects which the S's discussed, which the author had some difficulty in comprehending mainly due to his own lack of knowledge in these subjects. In one example given earlier, the S's knowledge of musical instrument outclassed that of the author's by many factors. The author was unable to assess the level of awareness possessed by S in this field. The interview therefore was considered invalid - any measurement would refer to something other than what is assumed to be measured. This is only one of the criteria to determine if each interview is valid. There are others.

It was felt that if there was no rapport between the interviewer and the S then the chances of the interviewer making an accurate judgement about the S's levels of awareness will be difficult. Further, even if a feeling of fellowship existed between the interviewer and the S, if there was not enough information coming from the S then the interview must be invalid - this applies to the information on both CA as well as GA.

In certain rare circumstances it is possible that an antagonism develops during an interview say for example if the interviewer asks a question which makes the S feel uncomfortable. During the trial interviews the author himself felt that the S was trying to win a point over the author rather than state what he felt was his true opinion. There was a sufficient amount of information given by the S, and indeed there seemed to be a rapport but the author had a sneaky feeling that there was a certain amount of antagonism on the part of S. The situation was that S was expressing his feeling that the unions were responsible for causing chaos in the country by heavy wage demands and by striking. He was making the point that he opposes the idea of industrial action. A little later he mentioned that the doctors were not being treated fairly. He proved it by saying that for the first time in the history of this country, the honourable profession was reduced to threatening industrial action. The author asked him did S then think that industrial action was acceptable in certain circumstances. The S gave a broad smile and gave an affirmative answer. But the author felt that S did not like being 'exposed' in this way and this lasted for the rest of the interview.
One other possible cause was detected by the author while interviewing the learners in schools. Occasionally there were interruptions during the interviews. Sometimes there was a knock on the door which the interviewer had to answer, sometimes a child ran straight in. These interruptions were minor and the author felt did not actually disrupt the interview enough to destroy the flow of communication. But once two boys came fighting into the room and it took some minutes to resolve the conflict. After the dust had settled down, the interviewee was obviously agitated. The interview was completed but it was obvious that the interviewee was unable to concentrate properly on the discussion.

Based on the above conditions being met one could say that an interview was valid. The conditions are now listed altogether:

(a) A substantial part of the subject area covered was within the reach of the interviewer.

(b) A rapport existed between the interviewer and the interviewee.

(c) Enough information emerged on CA and GA from the respondent.

(d) There was no underlying antagonism between the interviewer and the interviewee during the interview.

(e) There was no major interruption during the interview.

17.4 The Assessment Sheet

The assessment sheet in fact is nothing more than a record sheet with blanks for all the items arising out of the previous section, and which need recording. It would have been very easy to ask the interviewers to give a mark between -3 and +3 for each valid interview. But it was felt that unless the interviewers made a conscious decision on each of the contributory factors to the validity of the interview, they might miss one or more of them. The tendency to declare an interview valid must be very strong. To try to reduce the incidence of erroneous judgement on validity all the questions arising out of the analysis are answered discretely before it is decided whether the interview is valid.
On the question of actual assessment of levels of CA and GA, the first decision recorded is only if CA=GA, CA>GA or CA<GA without actually grading the difference if it exists. The second step in assessment is the actual grade on a three point scale if CA≠GA.

For comparison purposes it would be interesting to work out the effect of a number of kits gone through by a learner on the level of CA acquired by him. Likewise it would be interesting to find out if one kit rather than another was more effective. To answer questions like these it was decided to include recording this information on the sheet. It was placed at the end of the sheet after the interviewer had made the decision on the level of CA so as not to influence it.

The Assessment Sheet obviously included the blanks for the details of the respondent, the name of the interviewer for the record.

The next chapter deals with the training of the interviewers and with the reliability of the measurements.
## Chapter 18

### The Summative Evaluation: The Reliability of the Measurement

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<tr>
<th>Section</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
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<td>18.1 INTRODUCTION</td>
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<td>18.2 RELIABILITY: THE PROBLEM</td>
<td></td>
<td>240</td>
</tr>
<tr>
<td>18.3 RELIABILITY: THE SOLUTION</td>
<td></td>
<td>243</td>
</tr>
</tbody>
</table>
CHAPTER 18

THE SUMMATIVE EVALUATION: THE RELIABILITY OF THE MEASUREMENT

18.1 Introduction

Any instrument of measurement must meet the following two requirements:

(a) It is valid, as defined earlier.
(b) It is reliable i.e. like a ruler, it measures in the same way every time it is used.
(Hartley, 1972)

The question of validity and the means of achieving it was discussed in the last chapter. It was shown that for the present purposes it was not enough that the procedure of evaluation was valid generally, it was necessary that each interview was tested for validity as well. Since the all important part of the instrument, i.e. which actually does the measurement, is the interviewer, it is important that he or she should go through a rigorous process of calibration. This was done through a process of training.

Reliability, likewise, was also established through this process. This chapter first discusses the concept of reliability as applied to this present situation, then the training procedure to meet the requirements of reliability and validity, and finally the results of this procedure.

18.2 Reliability: The Problem

The special problems facing the present procedure regarding reliability are:

(i) There were six interviewers with their own ideas about the grading of various levels of awareness. This inevitably means that various interviewers will give different grades for the same level of awareness. Indeed during the first training session the grade of CA-V-GA recorded by the six would-be interviewers for the same sound tape of an interview with a respondent showed an alarmingly large scatter. This result
and those for the other training session are given altogether in section 18.3. So the first special problem relating to this situation was to develop means by which, ideally, all the interviewers recorded the same grade of CA-V-GA for a given interview. This problem can be seen as that of calibration of the measuring instrument.

(ii) The second problem relates to the manner in which the interviewer conducts the interviews. Once again this problem is best understood, in the first instance, with the help of an example from physical sciences. When an instrument is used to measure a current flowing through a circuit, then the problem is mainly of calibration. If the instrument reads a quantity which is equal to the actual current then the instrument can be said to be reliable. However the problem is categorically different if the instrument itself is supplying the potential difference as can be the case, for example, when it is used to measure a resistance. In this situation the reading does not only depend upon the measurement component of the instrument but also on the set up which supplies the potential differences. Clearly if the PD applied varies with each measurement of the same resistance, the reading will also vary. This becomes a real problem if six separate but similar instruments are used. It is therefore necessary that all the instruments supply the same PD for measurement of a resistance to obtain the same reading.

In the conditions dealing with levels of awareness therefore it seems that equal amounts of feeding of information, of insistence for an answer and of various other such pressures be applied to the respondent during an interview.

It is true that the five criteria set up for the validity of an interviewer deal with more blatant causes of unreliability, but this particular cause must be dealt with during the training of the interviewers. As it happened the awareness of this need linked with the fairly long experience of the teachers involved in dealing with children, this part of reliability resolved itself fairly early on during the training procedures. Details are discussed again in section 18.3.
(iii) Long term reliability perhaps should be suspect in human beings even more than in the physical instruments. An Avo-meter has a knob to set the pointer to zero every time it is used to measure resistance. Unfortunately, there is no such knob available for humans. A means therefore is required to maintain long-term reliability as far as possible.

(iv) Finally the all-important question that the reading which the instrument is giving is the true measure of the quantity involved must be dealt with. This is generally achieved by comparing the reading against a known quantity. Thus a certain length of metal bar at Trafalgar Square provided a standard against which other yardsticks were calibrated. Somebody sometime in the past said 'I define a yard to be the length of this bar of metal'.

As was pointed out earlier in this chapter there is no such yardstick for awareness against which all other awarenesses may be measured. In the present evaluation an alternative was made to overcome this difficulty in two ways.

(a) First of all since this method compares the two levels of awarenesses, the actual yardstick used is comparatively unimportant provided it is the same for both the awarenesses involved. This, in fact, is another major reason why a comparison is more appropriate than two independent measurements on some absolute scale.

(b) The standard for the measure of the differential of the two awarenesses involved was established by the members of the Working Party who took on the same role as the wise old men of the past when they decided to call a certain bar of metal a yardstick. Ultimately any original standard must be arbitrary. But provided the subsequent standards all conform to this original standard, this need not cause any great hardship. The wise old men of the past, however, had a great advantage over the humble members of the Working Party: they, the wise old men, were able to define their yardstick simply and elegantly. A yardstick for measuring awareness cannot be as simple.
In the absence of knobs on the interviewers to adjust the levels, attitudes etc., to some common standard, the only approach available was tried: that of training the interviewers.

Since it would be overpowering for a respondent if six teachers sat around when one of them interviewed him, it was decided to record a number of interviews on sound tape. These interviews were then replayed during training sessions. This was followed by a detailed discussion on the way the interview was conducted and on the levels of CA and GA demonstrated by the respondent. Then all concerned gave a mark for $CA = GA$ or $CA < GA$ or $CA > GA$. Finally if $CA < GA$, then a mark on a scale 1 to 3 was given for the differential between CA and GA. As suggested before, the results of the first interview showed a large scatter. This was followed by a discussion. Unfortunately only one tape was available that day. It seemed that if the same tape as for the first trial is repeated, there might be too much social pressure on those who scored too high or too low to "fall in line" with the others. The full result of this trial and others is given in the Appendix under 'Interview Training Trials 1 to 8'. The abstract is given in Table 20.

The total period for training was some three months in which eight trials were held. It was obvious from the start that if a change in attitude of an interviewer is to last out the actual evaluation period then it must take place over a comparatively long period. From this point of view it was felt that the shorter the actual evaluation period the better. In the event this period could not be reduced to less than about two months.

Getting back to the results, the second trial took place nineteen days after the first trial. As can be seen the scatter is considerably reduced. After the discussion a tape recorded by another interviewer with another respondent was listened to and the results recorded. There is no difference to the scatter. Trials three, four and five show similar scatter. This was some two months after the trials started and it seemed that there was not going to be any better agreement. However two more trials were held that day and as can be seen (for trials six
<table>
<thead>
<tr>
<th>Trial</th>
<th>Date</th>
<th>Inten Val</th>
<th>CA&lt;CGA</th>
<th>CA&lt;CGA</th>
<th>CA=GA</th>
<th>CA=GA</th>
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<td>1</td>
<td>2</td>
<td>1</td>
<td>2</td>
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<td>26.11.75</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>2</td>
</tr>
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<td>26.11.75</td>
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<td>2</td>
<td>3</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>4</td>
<td>11.12.75</td>
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<td>1</td>
<td>2</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
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<td>14.1.76</td>
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<td>1</td>
<td>5</td>
<td>1</td>
<td>5</td>
</tr>
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<td>6</td>
<td>18.2.76</td>
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</tbody>
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**TABLE 20**

**INTERVIEW TRAINING TRIALS**

**ABSTRACT OF RESULTS**
and seven) there was an improvement. In fact the results of trial seven
\((\text{CA}<\text{GA})=5 \text{ and } (\text{CA} = \text{GA})=1\) were not bad. It was decided that this might
be the limit of resolution obtainable in the given circumstances. The
question 'will this resolution be maintained over a period of time'
still remained. To this effect another test was held 3½ days later with
the same result. At this stage it was agreed that the proper evaluation
should commence. At this point it might be said that all the members
of the Working Party were quite satisfied that an acceptable level of
reliability had been achieved. None the less it is not possible to be
categorical about this as human judgement can never match the accuracy
of a physical instrument. Having said that, the final judgement in
educational courses is always human and if a set of teachers, who quite
consciously were training themselves to be objective, were prepared to
treat this course as acceptable if the results of evaluation were good,
then it may be assumed that the course probably did meet its objectives
as far as it is possible to ascertain.

During the many discussions that followed each trial the question of
what is being measured is awareness and not something else such as the
'verbal intelligence' for example, always cropped up. And it was clear,
towards the end of the training period, to everyone involved, that they
understood exactly what awareness meant - at least they all agreed as to
what awareness meant. This then was the limit to which this evaluation
procedure can be said to be valid. It is possible that another set of
teachers would define awareness differently but there was a surprising
amount of agreement within this set that the awareness meant what has
been defined in the earlier pages of this thesis.

Another aspect of the training was an agreement of the way the interviews
were conducted. Everybody contributed at least one interview and as the
time passed there was less and less criticism of the manner in which the
interviews were conducted by the trainees. Once again towards the end
of the training session all were quite certain about the approach they
would adopt for conducting the interviews.

Finally it may be useful to record the role the author playing during the
training sessions. His was not the role of a Sergeant Major who trains
a set of soldiers to act and think as one preferably like himself. It
was rather that of a prompter who helped the trainees to become conscious of their own attitudes, which are normally latent, and to justify them publically and then either persuade others to meet their own standards or be prepared to be persuaded by others to change them. And it was not a question of the majority carrying the day either. Quite often an argument supporting a minority won the day.

Against great temptations the author did not replay any of the inter­views he had recorded himself so as to minimise the influence on the others. In fact as it dawned on the trainees that looking to the author for answers to some of the tricky questions was a waste of time, the discussions became free and lively. It will be true to say that at this stage, perhaps for the first time, the author understood the colossal amount of thinking which the teachers put behind their practice. There were not many points raised, no matter how trivial, that were brushed aside.

Having completed, albeit imperfectly, the training of the interviewers, the summative evaluation was then carried out whose results are given in the next chapter.
# CHAPTER 19

THE SUMMATIVE EVALUATION: THE RESULTS

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<td>Contribution made by each Module</td>
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<td>19.5.5</td>
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</tr>
<tr>
<td>19.5.6</td>
<td>By School</td>
<td>261</td>
</tr>
<tr>
<td>19.6</td>
<td>SUMMARY AND GENERAL COMMENTS</td>
<td>262</td>
</tr>
</tbody>
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CHAPTER 19
THE SUMMATIVE EVALUATION: THE RESULTS

19.1 Introduction

To make this chapter self-contained as far as possible, the definitions of the objective of the summative evaluation and of the instrument of measurement are given first. The results of the evaluation and their interpretation then follow. The reader is reminded again that the course on computer awareness was not designed to impart any technical knowledge about computers but to develop a facility to deal with matters concerning daily lives, and to meet the requirements of what truly can be called 'computer education for all'. If the reader has a sympathy with this objective he will find the results of the summative education, if not gratifying, then at least bearable.

It took some four and a half years from inception of the idea to the end of the evaluation. During this period a number of dedicated teachers consistently helped with the initial trials of the educational material, the formative evaluation and the summative evaluation. The full list of the members of the working party is given earlier on page 112. The six teachers who put in most effort throughout were also those who were involved with evaluation. The author wishes to record his appreciation of their contribution to this work.

Chris Bishop  Godalming College
Hilary Broadhurst  Mowbray School
Bruce Halsey  George Abbot
Graham Howlett  Charterhouse
John Knight  Sonds Place
Valerie Knight  Godalming College
Mike Page  France Hill

Due to sickness Valerie Knight was unable to go through the training programme for evaluation. She therefore did not conduct actual interviews. Graham Howlett was unable to conduct any interviews because of the heavy demands made on his time by his other duties in his school. Their contribution, nonetheless, was substantial.
The author himself did not conduct any of the interviews which formed part of the sample. The only interviews he conducted were for understanding and improving the evaluation procedure.

19.2 The Objective of the Summative Evaluation

"... this evaluation procedure will determine the level of facility to make social and general inferences on the basis of what the learner sees or hears about computers as compared to his level of facility to make inferences on the basis of what he sees or hears about situations not involving computers, possessed by him if he carries out the procedures prescribed in the course on Computer Awareness", on the scale

| CA very much less than GA | -3 | -2 | -1 | 0  | +1 | +2 | +3 | CA very much greater than GA |

19.3 The Instrument of Measurement

The Instrument of Measurement will be trained evaluators who will

(a) conduct semi-structured interviews, which will have a common element as defined in the document "Guideline for the Interviews",

(b) record the results of the 5-point criteria for the validity of the interview, and

(c) record the result of the comparison of the CA and GA on the 7-point scale on the "Assessment Sheet".

19.4 The Sample

Size: 180
Valid: 170
Invalid: 10
Ability: Random (presumed all ranges)

Distribution by age (in years):

<table>
<thead>
<tr>
<th>Age</th>
<th>12</th>
<th>15</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>13</td>
<td>42</td>
</tr>
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<td></td>
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<td>42</td>
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</tr>
<tr>
<td>Total</td>
<td>170</td>
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</tr>
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</table>

Distribution by School:

<table>
<thead>
<tr>
<th>School</th>
<th>52</th>
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<tbody>
<tr>
<td>George Abbot</td>
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<td>France Hill</td>
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<td>Sonds Place</td>
<td>20</td>
</tr>
<tr>
<td>Total</td>
<td>170</td>
</tr>
</tbody>
</table>

19.5 **The Results**

In interpreting the following results one main point needs to be kept in mind: on the scale \(-3\) \(-2\) \(-1\) \(0\) \(1\) \(2\) \(3\) \(0\) represents \(CA=GA\) and not \(CA=0\). Thus the objective of the course will be that all the respondents scored 0. They will be scoring \(-3\) if \(CA=0\). The scale of 0 to 6 was considered but this would not have clearly shown any negative results i.e. when \(CA<GA\). The scale chosen, once understood, clearly shows the distribution of the sample around the axis \(CA=GA\).

19.5.1 **Overall Results**

The overall scores for the sample are given in Table 21 and in Bar Chart 1.
### Table 21

<table>
<thead>
<tr>
<th>CA-V-GA</th>
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<th>Frequency</th>
</tr>
</thead>
<tbody>
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<td>0</td>
</tr>
<tr>
<td>CA&lt;GA</td>
<td>-2</td>
<td>2</td>
</tr>
<tr>
<td>CA&lt;GA</td>
<td>-1</td>
<td>16</td>
</tr>
<tr>
<td>CA=GA</td>
<td>0</td>
<td>71</td>
</tr>
<tr>
<td>CA&gt;GA</td>
<td>+1</td>
<td>62</td>
</tr>
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<td>+2</td>
<td>19</td>
</tr>
<tr>
<td>CA&gt;&gt;&gt;GA</td>
<td>+3</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>170</td>
</tr>
</tbody>
</table>

Mean = 0.47
There is no great skill required to interpret these results. Obviously it would have been better if the whole sample scored 0 or more. Sixteen who scored −1 still must have learnt something. Two who scored −2 clearly were totally lost — but then they represent only two in a sample of 170.

The reader might have noticed that one of the interviewers consistently gave a score of 1 more than others during the trial runs of the taped interviews. In a way this was because he found it difficult to 'fall in line with others'. If it is assumed that this interviewer continued with his generosity then a correction might be applied by reducing all his readings by a count of 1. As it happens his was one of the largest sample as well (38 from France Hill). Table 22 and Bar Chart 2 gives the corrected figures for the overall evaluation.

<table>
<thead>
<tr>
<th>CA-V-GA</th>
<th>Count</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>CA&lt;&lt;GA</td>
<td>-3</td>
<td>1</td>
</tr>
<tr>
<td>CA&lt;GA</td>
<td>-2</td>
<td>3</td>
</tr>
<tr>
<td>CA&gt;G</td>
<td>-1</td>
<td>26</td>
</tr>
<tr>
<td>CA=GA</td>
<td>0</td>
<td>72</td>
</tr>
<tr>
<td>CA&gt;GA</td>
<td>+1</td>
<td>59</td>
</tr>
<tr>
<td>CA&gt;&gt;GA</td>
<td>+2</td>
<td>9</td>
</tr>
<tr>
<td>CA&gt;&gt;&gt;GA</td>
<td>+3</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>170</strong></td>
</tr>
</tbody>
</table>

Mean = 0.25

Table 22
The general shape of the curve remains the same. The main difference is that the mean score has dropped from 0.47 to 0.25. Considering that the aim of the course is to bring computer awareness to the same level as general awareness possessed by the respondents (which is equivalent to a mean score of 0) the mean score of 0.25 is just about acceptable. It should have been expected that since CA is taught and GA is gathered without any formal teaching, the level of CA should be slightly higher than that of GA. Also, whereas one of the assumptions made earlier was that if a threshold is crossed in an awareness then the individual concerned will continue to assimilate further awareness since the likelihood of a formal education for the school population as a whole is remote, there will be a slight drop in the level of CA before it reaches a steady state. Altogether the overall result should not be interpreted as anything more than just meeting the objective of the course.
19.5.2 Rediscovering the Human Scale

One of the surprising results of the score found incidently is that in spite of the fact that a 7-point scale was developed, in fact there were no scores for the two extreme points of -3 and +3. (In the corrected figures there is a score of 1 for -3 but then the score for France Hill is only on the scale -3, -2, -1, 0, +1. In any case a count of 1 in 170 may be ignored for the present analysis.) This effectively creates a 5-point scale - a confirmation that it is hard to improve on human resolution whatever devious means are employed.

The other argument sometimes employed to explain this result is that humans tend not to score extreme points on a scale. This might well be true in certain circumstances, but in the present context it has already been shown that a 5-point scale can be fully utilised when the respondents filled in the feedback sheets (for example see page 206).

19.5.3 By Number of Kits

The course was organised in such a way that the learners started the course by watching the tape/slide sequence followed by a class discussion with the teacher. After this the course became self learning and the learners carried out the task in 'Introduction to the Computer Terminal'. Then they were advised to do 'Stock Control' followed by the rest of the three kits in any order they wished. However two variations from the above pattern were noticed in the results as recorded in the assessment sheets. First, that many children did not complete the whole course. The count for the number of modules, including the tape/slide, completed is given Table 23.
Frequency by Number of Kits

<table>
<thead>
<tr>
<th>Number of Modules</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>18</td>
</tr>
<tr>
<td>5</td>
<td>105</td>
</tr>
<tr>
<td>6</td>
<td>44</td>
</tr>
<tr>
<td>Total</td>
<td>170</td>
</tr>
</tbody>
</table>

Mean = 5.09

Table 23

The second variation was that some learners did not watch the tape/slide, and some did not carry out the task for 'Introduction to the Computer Terminal'. From one point of view this meant that part of the sample left out what were considered essential modules. The overall result, given in the last section, therefore, was inspite of this shortcoming in the course as actually practiced. From another point of view it was fortuitous as this gave an opportunity to assess the comparative contribution made by these modules to raising the level of CA in the learner. This is discussed further in the next section. In this section are given the results of evaluation by number of kits.

The count of 3 for those who did either 2 or 3 modules is ignored as it can hardly be significant. The result for the rest are given in Table 24 and Bar Chart 3.
### CA-V-GA by Number of Modules

<table>
<thead>
<tr>
<th>CA-V-GA</th>
<th>Value</th>
<th>Number of Modules</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>CA&lt;&lt;GA</td>
<td>-2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>CA&lt;GA</td>
<td>-1</td>
<td>8</td>
<td>6</td>
</tr>
<tr>
<td>CA=GA</td>
<td>0</td>
<td>6</td>
<td>40</td>
</tr>
<tr>
<td>CA&gt;GA</td>
<td>+1</td>
<td>3</td>
<td>44</td>
</tr>
<tr>
<td>CA&gt;&gt;GA</td>
<td>+2</td>
<td>0</td>
<td>15</td>
</tr>
<tr>
<td>Mean</td>
<td></td>
<td>-0.22</td>
<td>0.64</td>
</tr>
</tbody>
</table>

Table 24

Bar chart 3
As the graph shows those who did only four modules score CA of -0.22 i.e. they scored a level of 0.22 below their level of GA. The fifth module seems to have raised the level of CA by 0.86 over those who did only four modules. This suggests that the minimum number of modules required to bring the level of CA at par or above that of GA is five. Those who did the sixth module seemed to have raised their level of CA only by another 0.04 on a, say, 5-point scale i.e. by less than 1%. A deduction may be made that for most learners similar to the ones in this sample, five modules will suffice - further modules to be done only by those who need extra help or those who are particularly interested in the activity.

**Contribution made by each Module**

As suggested in the last section, it may be of interest to discover the comparative contributions made by each of the modules. The author was of the opinion that the learners will not easily acquire CA unless they had a visual and conceptual image of the computer. If this were true then the results should have shown that those respondents who did not watch the tape/slide sequence scored very low on the scale. The results were the exact opposite of this.

It might be noted that the tape/slide production was the most expensive single module in resource and time. It would seem, therefore, that the most expensive educational modules are not necessarily the best.

An attempt is made in working out the comparative contribution made by each module. The mean score is first computed, in turn, for parts of the sample, who did not do a particular module (column A of Table 25). This figure is then subtracted from the overall mean of .47 (column B) to give the comparative contribution made by each module. However the two figures (columns A and B) also have another major variable: the number of modules completed by the respondents. For this reason this result cannot be said to be valid. It is given here only for interest. These results are given in Table 25 and Bar Chart 4.
Comparative Contribution made by each Module

<table>
<thead>
<tr>
<th>Module</th>
<th>Mean Score</th>
<th>Overall Mean</th>
<th>( C ) Comparative Contribution made by the Module B-A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tape/slide</td>
<td>0.32</td>
<td>0.47</td>
<td>0.15</td>
</tr>
<tr>
<td>Introductory</td>
<td>-0.45</td>
<td>0.47</td>
<td>0.92</td>
</tr>
<tr>
<td>Stock Control</td>
<td>-0.50</td>
<td>0.47</td>
<td>0.97</td>
</tr>
<tr>
<td>Fire Engine</td>
<td>-0.33</td>
<td>0.47</td>
<td>0.80</td>
</tr>
<tr>
<td>Aid to Education</td>
<td>-0.31</td>
<td>0.47</td>
<td>0.78</td>
</tr>
<tr>
<td>Aid to Planning</td>
<td>-0.02</td>
<td>0.47</td>
<td>0.49</td>
</tr>
</tbody>
</table>

Table 25

Bar chart 4
The only major surprise is the very low contribution made by the tape/slide production. Seeing this result, the author went back to a number of respondents, some of whom had watched the tape/slide sequence and some had not. The general impression gathered was that whereas the sequence did not help to add to the properties of the computers assimilated by the learners directly, those learners who did watch it benefitted greatly as it helped them to have an idea of the machine they were dealing with. In a way this was the sole objective of this module but unfortunately this evaluation does not bring it out. To this extent, this evaluation procedure has been inadequate. If the author and others involved had been fully aware of the need of evaluating the efficacy of this module slightly differently it would have been no big task to include a separate section in the interviews to this effect. However as it stands it seems that the tape/slide made very little contribution in raising the level of CA.
Another interesting analysis done is the score of CA-V-GA by age. It would have been expected that since only a comparison between CA and GA is measured, any higher GA level for older respondents should only be compatible with the higher level of CA as a result of doing the course. In other words if the course was truly for all secondary school age ranges, then the result should have been a straight line. This in fact is not the case. The results are given in Table 26 and Graph 13.

### Table 26

<table>
<thead>
<tr>
<th>Score</th>
<th>Age in years</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>12</td>
<td>13</td>
</tr>
<tr>
<td>CA&lt;GA</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>CA≤GA</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>CA=GA</td>
<td>6</td>
<td>18</td>
</tr>
<tr>
<td>CA&gt;GA</td>
<td>7</td>
<td>18</td>
</tr>
<tr>
<td>CA&gt;&gt;GA</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Mean</td>
<td>0.73</td>
<td>0.5</td>
</tr>
</tbody>
</table>

### Graph 13
As can be seen, there is a gradual decrease in the mean score of 0.73 for 12 year olds to 0.28 for the 17 year olds. It could be that 12 year olds have very little GA, therefore it takes less education in CA to match it and that 17 year olds have already gathered a considerable amount of GA and will need more education in CA to bring its level at par with GA. This makes sense for another point of view. Since 17 year olds took longer (17 years?) to gather GA than the 12 year olds, they will need more education modules to gather the same amount of CA.

Since the feedback indicated that the interest levels scored by various age groups (Graph 10 page 212) did not show a general trend downward, another possible explanation that the modules were 'trivial' i.e. had no new information, for the higher age ranges cannot be accepted. The explanation, therefore, must remain that the higher age ranges require more modules to bring their CA levels at par with their higher GA level.

19.5.6 By School

The mean of CA-V-GA by School is given in Table 27 with the mean age for the sample from each school. The result is also given in the Bar Chart 5.

<table>
<thead>
<tr>
<th>School</th>
<th>Geo. Abbot</th>
<th>France Hill</th>
<th>Godalming</th>
<th>Mowbray</th>
<th>Sonds Place</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean CA-V-GA</td>
<td>0.5</td>
<td>0.75</td>
<td>0.26</td>
<td>0.26</td>
<td>0.45</td>
</tr>
<tr>
<td>Mean Age in Years</td>
<td>12.9</td>
<td>14.9</td>
<td>16.5</td>
<td>15.9</td>
<td>14.6</td>
</tr>
</tbody>
</table>

Table 27
As can be seen there is a large variation between schools. The only comment that can be legitimately made is that the high score of 0.75 for the sample from France Hill may be related to the generous scoring given by the interviewer involved as already mentioned in section 19.5.1 on page 252. Apart from that the results seem reasonable. The results are given here more for record than for any light they may throw on the factors concerned with the variation.

19.6 Summary and General Comment

To sum up, the overall results achieved by the course showed that the respondents reached a level of 0.25 for CA above their existing level of GA. These results may be considered adequate but by no means brilliant. But remembering that the objective of the course was to reach a level of CA at par with GA taking into account that the children will take odd periods off from their normal timetable (in all five hours of learning time for CA), that the expertise required from the supervising teachers will be minimal and that the course is designed for all abilities and age ranges, the reader might agree with the author that the overall performance of the course as a whole is in fact reasonable.

The total cost on resource and material is one set of modules per school, say, per year, one teletype, and some five hours of computer time per two children. The teacher time is confined to his going through the modules once, a one hour period to show the tape/slide sequence to a group as a whole, and time required to organise the timetable. As was shown the actual help required by children once they got going is very little (less than once per pair of children, table 6, page 201).

The result showed that there was a considerable increase in CA-V-GA from -0.22 to 0.64 for those who did five modules from those who did only four. The increase in CA-V-GA was minimal for those who did one more module.

In trying to assess the comparative contribution made by each individual module, there was great difficulty in isolating the effect of each module. However such analysis as was possible showed that the most
expensive module, the tape/slide production, made least contribution. Low contribution was made by the kit 'Aid to Planning Committees'. This contribution was lower than expected. The contributions made by the other four kits were approximately equal.

The results showed that a smaller amount of learning is required to match the level of CA with the existing level of GA at a lower age than at a higher age, probably because the level of GA at higher ages is greater. There is no evidence that the course made more contribution at lower ages, only that at lower ages the level of CA reaches that of GA more quickly. But a premise offered was that if a minimum of awareness exists in a person, then further awareness is naturally acquired through the social process of information diffusion. One may therefore conclude that a course such as this may be best given early in a secondary school rather than late. The premise mentioned above however could not be confirmed due to the short time scale of this thesis. The conclusion therefore must remain tentative.

The variations in the results shown by schools may be due to many factors such as the way each school is organised, the noise level in the teletype room, the attitude of the teachers etc. It is not for the author to comment on this, nor was any attempt made to investigate this. However, the samples from all the schools achieved the basic objective of the course and that was considered sufficient for the present purposes.
### Summary and Appraisal

#### The Definitions

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<td>275</td>
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<td>Module No. 6 'Computer as an Aid to Planning Committee'</td>
<td>276</td>
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<td>20.10</td>
<td>Module Type B 'Introduction to Computer Terminal'</td>
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</table>

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<td>281</td>
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<td>282</td>
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<td>The Summative Evaluation: The Objectives and Procedure</td>
<td>284</td>
</tr>
<tr>
<td>20.17</td>
<td>The Instrument of Measurement</td>
<td>284</td>
</tr>
<tr>
<td>20.18</td>
<td>The Reliability of the Measurement</td>
<td>284</td>
</tr>
<tr>
<td>20.19</td>
<td>The Summative Evaluation: The Results</td>
<td>285</td>
</tr>
<tr>
<td>20.20</td>
<td>Appraisal</td>
<td>286</td>
</tr>
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</table>
CHAPTER 20

SUMMARY AND APPRAISAL

Introduction

This work started as a protest against the view that popular education about computers has to be watered down versions of computer science. The author took it upon himself to investigate other possibilities. Starting from first principles the idea of Computer Awareness was developed and implemented for schools. The following account is a brief resume of the processes developed to achieve this. Computer Awareness is defined as "The possession of sufficient knowledge to enable inferences, general and social, to be made on the basis of what is seen or heard about computers" (page 15). The three main challenges thrown at the author through the early period of his effort were:

(i) You cannot define Computer Awareness in terms suitable for teaching practice.

(ii) Even if you can define it so, you cannot develop suitable material to teach it, and

(iii) Even if you develop the material, you cannot be sure that you have succeeded.

The account of how the author attempted to meet these three challenges is given in the three parts of the thesis, the Definition, the Implementation, and the Evaluation of a course for Computer Awareness. The text in quotes is from the main body of the thesis and is followed by page numbers.

The Definitions

20.1 Computer Education for All

20.1.1 The State of the Art

Before the actual definition for Computer Education for All is attempted a general survey of 'The State of the Art' is given. The general opinion at the time (C 1970) seems to have been that
"(a) All people should have some knowledge about computers because of their social and political implications, and

(b) This knowledge is computer science albeit at a low level." (11).

It is suggested that the objective given in (a) is not met by the prescription given in (b) otherwise "if Mary Whitehouse considers it important that she exert an influence on the changes brought about by broadcasters, she should become well versed in the important concepts of radio equipment".

"One might genuinely wonder if it is practical for everybody to start the study of databanks by doing runs in binary arithmetic. It is like trying to develop an understanding of the social nature of man from the study of the human anatomy". (11, 12).

20.1.2 The Definition of Computer Education for All

Starting from first principles, various arguments are given why it may be necessary to have Computer Education for All, at all. They are summed up as "The aim of Computer Education for All is to reduce the bewilderment regarding computers in the minds of people, to help people to utilise computer based social services, to work without reticence in the computer environment, and to develop informed opinion about computer systems with political implications" (14). From this general argument is developed the definition of CA (Computer Awareness) as given at the start of this chapter.

20.1.3 The Nature of CA

The nature of general awareness which people possess is then discussed in detail to determine the structure of knowledge for CA, which is identified to include

"(a) the primary properties of computers as machines,

(b) the properties of computer systems as they are used in this society,"
(c) the properties of these systems in the social context e.g. their relationship with the other systems of the society, and

(d) an ability to transfer this knowledge to novel situations." (22)

There are but only two primary properties of computers:

"(1) Computers are fast processors of numeric and non-numeric information.

(2) Computers allow fast storage and retrieval of large quantities of information." (23)

Some of the other properties of the computers relating to (b) and (c) above are:

"(1) Computers can stay in a state of readiness, at all times, to deal with an emergency.

(2) It is possible to have incorrect information on a computer file.

(3) Computer systems make economic sense only if they make possible large savings in labour." (24)

etc.

20.1.3.1 Computer Awareness and Computer Science

Three questions can generally be asked about computers:

(a) What is a computer?
(b) How does a computer work?
(c) What does it do? (25)

It is suggested that (a) is answered by Electronics etc., (b) by Computer Sciences. CA concerns itself with (c) although it includes more than just computer applications.
"One view of the academic subject is that it is theoretical, broad and not directly related to life. The practical subjects are understood to mean narrow, concrete, and often nominal. CA seems to be a third category of education: it deals with general principles which are directly related to life." (26)

20.1.3.3 Computer Awareness and Value Complex

It is suggested that teaching of ethical values associated with computers is not part of CA. But "cognitive values such as the value of double checking the input to the computer, or that of not accepting the computer output as gospel truth are part of CA. Not included are absolute values such as "computers are good" or "computers are bad". (28).

20.1.3.4 Computer Awareness and Taxonomies of Educational Objectives

Bloom, Krathwohl and Masia (1971) seem to be in two minds about what they think awareness is. In one example for 'Awareness of the existence of the chief statesmen in international affairs" they give a test which is solely concerned with the recall of names of the statesmen or of the states. Yet they state earlier that 'awareness is not concerned with a memory of, or ability to recall an item or fact... In another example the test states its objective as 'Consciousness of colour, form, arrangement and design in paintings'. Awareness as defined in this thesis agrees with the spirit of the latter example and disagrees with the first. (30,21)

20.2 A Method of Learning

Having found a reasonable definition of Computer Awareness and its structure, it still remained to find a suitable method. For just giving a statement like 'Computers are fast processors of numeric and non-numeric information' to children would not suffice. It is suggested that since people do acquire awareness, there must exist a method which they use to acquire it. It is just a matter of discovering this method. An account is given on pages 34 to 38 as to how humans may be acquiring awareness.
Two essential ingredients of the situations in which human beings get curious and do something about satisfying this curiosity are

(i) they have at least partial knowledge of the event they are observing or believe that they have, and

(ii) they believe that they have a reasonable chance of finding out more about it." (36)

The Formal Definition of the Method is given in the form of Postulates:

(a) Human beings possess a cognitive map of reality in the form of functional units.

(b) Human perception of events has the following properties:

(i) it is dynamic

(ii) it is depending on the event as well as on the existing cognitive map

(iii) it comes in functional units.

(c) If the cognitive map relates, but only imperfectly, to the perception of an event then a motivation exists to render the relationship perfect.

(d) Learning takes place if

(i) the imperfection cannot be removed without co-opting a new functional unit into the existing cognitive map.

(ii) the total effort required to learn and to remove the imperfection is commensurate with the motivation generated.
20.2.1 The Cognitive Map of Reality

"Cognitive map of an individual does not consist of a 'photographic image' of reality with one to one correspondance. It consists of functional units derived from the use made of concepts in dealing with reality. These units have functional categories and functional levels dependent upon the categories and levels of use made of the concepts in the past." (42)

20.2.2 Human Perception

Pages 43-46 are devoted to the discussion of perception and its implication to learning.

20.2.3 Imperfect Relationship between Cognitive Map and Reality

"Imperfection may be perceived in a relationship between the cognitive map and the perception of an event if it is incomplete, or if a part of it is un- or under-defined or if a part of it does not fit the whole according to the cognitive map of the individual. Perception of imperfection can also arise out of experience of uncertainty". (48)

20.3 An Experiment

An experiment for Remedial Teaching of Reading in a school utilising the learning method is described. The objective of this exercise was twofold:

(a) To try to establish whether the method is workable from outside the field of CA, and

(b) To try to establish ground rules to prescribe a teaching method based on it. A full account is given in chapter 3. Some of the salient features are mentioned here:

20.3.1

"Reading was defined as recognition of written symbols which represent existing concepts in the cognitive map of the children. The new
functional units, which the children had to acquire therefore were not recognising written symbols for new concepts but for the existing ones. Children were learning to read rather than reading to learn". (61)

20.3.2

The existing cognitive map of the children was simply identified by asking them to narrate stories which were tape-recorded. These stories were transcribed as given and children were asked to read them. Since the words and the structure of the sentences etc., were their own they were truly learning to read. The cycle was repeated three times. Each time the text was slightly altered to make it more like standard English.

20.3.3

A record of the reading ages of the children involved for the previous 17 months was available. A careful record of the reading ages during the period of the experiment (some 10 weeks) was taken. The results showed that the rise in reading ages during the experimental period was at a rate of 3.38 years per calendar year compared with 1.12 years per calendar year during the previous 17 months. Comprehension and fluency tests also showed similar results (71,72).

20.4 A Method of Teaching

A prescription for a teaching method which is based on the Method of Learning as applied in the above experiment is given in chapter 4. The prescription of this method is reproduced here.

"The system of learning is so organised that

1. The initial activity is largely within the existing cognitive map of functional units of the learner.

2. At the start, and subsequently, it is perceived by the learner as a whole in which properties of each part are related to other parts and to the whole.
It is dynamic in which each event that takes place is perceived by the learner to be related to the previous events and is expected to be related to the events which may follow.

That the learners perceive an imperfection in the relationship between his cognitive map and the perception of the system at the start or soon after.

The action required to remove the imperfection as perceived by the learner will result in the acquisition of functional units, as envisaged by the designer of the system.

The effort required to learn is commensurate with the learner's motivation to remove the imperfection, i.e. the learner succeeds in removing the imperfection before he exhausts his motivation.

Every time that the learner renders the relationship perfect he is offered a fresh imperfection until the learning goal, as envisaged by the designer, is achieved.

At all times during the sequence the system (which is being modified as events take place), remains within the cognitive map of the learner, intended imperfection excepted." (104)

In the explanations which follow a point is made that "Elements of any human activity have a two dimensional relationship: one lateral and one temporal. As in a cinematograph film, where each element within a frame is related to the previous frames and those which follow, human cognitive activity is constituted of a set of events related in the two dimensions. All the related events form a whole". (107)

The Implementation

20.5 Requirement of Educational Material for CA

Part II of this thesis is devoted to the implementation of the ideas developed in Part I.

All the requirements for a course on CA are brought together in chapter 5.
The reader will find "Summary of Requirements for the whole Set of Modules" in the appendix. They are not reproduced here.

20.6 **The Organisation of the Course**

Based on the above, four broad but distinct aims for the modules emerge:

"(i) A module to provide visual and conceptual image of the computer so that the learners can relate to what follows in the course;

(ii) A module to serve as an introduction to the computer terminal to enable the learners to acquire the skills necessary to use the kits and to overcome any fear they might have of computers;

(iii) Modules to give experience of computer applications in as realistic a fashion as possible; and

(iv) Modules to give experience of properties of computer systems relevant to CA." (121)

Since the same modules serve the objectives (iii) and (iv), only three types of modules are required.

<table>
<thead>
<tr>
<th>Type A</th>
<th>Module 1</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>To provide visual and conceptual image of computers</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Type B</th>
<th>Module 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>To serve as an introduction to the computer terminal</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Type C</th>
<th>Modules 3, 4, 5, 6</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>To give experience of computer applications</td>
</tr>
<tr>
<td></td>
<td>To give experience of properties of computers relevant to CA</td>
</tr>
</tbody>
</table>

Module 1 took the form of a tape/slide production, modules 2-6 were packages made up to computer programs and instruction booklets. The reader might like to take them out of the back pocket.
FOUR CRITICAL STAGES OF THE LEARNING SEQUENCE

STAGE 1

Concept of the Automatic Shoe Factory which relates directly to the existing cognitive map of the children

Intermediate frames

Concept of the Automatic Shoe Factory which is directly transferable to the concept of the Automatic Information Factory (without the details of the stores)

Intermediate frames

Concept of the Automatic Information Factory (without the details of the stores)

STAGE 3

Concept of the Automatic Shoe Factory which includes the details of the various stores, transferable directly to the equivalent concept of the computer

Intermediate frames

Concept of the computer which includes the details of the three speed stores

STAGE 4

Visual image of the various hardware components of a computer system, each one relating to the equivalent components of the concept

Figure 5
20.7  Educational Module Type A

Visual and Conceptual Image of the Computer

The main purpose of this module was to bridge the gap between their existing cognitive map and that assumed for the rest of the course which involved using the computer via a terminal. This was carried out by starting this module with the general concept of a fully automated factory manufacturing some familiar product. One major problem to be solved was the concept of various speeds of stores. This and the four critical stages of the learning sequence are reproduced in Figure 5. (30)

20.8  Educational Module Type C (Numbers 3, 4, 5)

These modules were developed before Type B as the context of Type B depended on the requirements arising out of Type C.

Objectives

1  Learners will experience a number of computer applications.

2  Learners will experience properties of computer systems relevant to CA.

Pre-experience

1  Gone through the tape/slide (Module 1).

2  Carried out the work prescribed in the kit 'Introduction to the Computer Terminal' (Module 2). (137)

20.8.1

The reasons for not getting the children to write their own computer programs were that the children lacked the experience to write computer programs adequately to demonstrate the relevant properties, that it would definitely take longer than 10 hours allowed for, that it would need more expertise for teachers than assumed. In any case the ability to write computer programs was not part of CA (138).
Four kits (as these modules came to be known) were developed:

(i) Stock Record by Computer
(ii) Computer Planned Routes for Fire Engines
(iii) Computer Aided Learning
(iv) Computer as an Aid to Planning Committees

The reason for selecting these applications and rejecting for example, 'Module of National Economy' and 'Seat Reservations for Airlines' and procedure for development of the kits are given on pages 140 to 144.

20.8.3 Some Special Features

(i) In all the kits the actual learning instructions are provided on the right hand pages. All the supporting material is provided on the left hand pages.

(ii) Computer jargon is introduced, if absolutely necessary, 'in use'. Definition of words were avoided. See, for example, the word 'INPUT' and 'data' in instruction 6, page 2 of 'Stock Control' kit (144).

(iii) Although writing computer programs is not part of the objectives of the material for CA, what a computer program looks like is (146).

20.9 Module No. 6 'Computer as an Aid to Planning Committees'

Chapter 9 describes the detailed development of one kit and how it meets the requirements (150-160).

20.10 Module Type B 'Introduction to Computer Terminal'

This kit was specially written to introduce the learner to the live computer. It also served the purpose of enabling the learners to develop skills required to carry out the instruction in the subsequent kits.
The objectives of the kit are reproduced here:

1. The learners will experience typing on the computer terminal.

2. The learners will experience some special symbols utilised by the computer terminal e.g. \( \times \) (multiply) and \( \text{to the power of} \).

3. The learner will experience login and logout procedures and use the machine for some elementary processing.

4. The learner will experience some error messages for the machine.

5. The learner will experience some remedial procedures when an error is made.

6. The learner will experience procedures for recalling and using a stored computer program.

7. The learner will experience the following CA properties:

   (i) Computers are capable of reproducing a text.

   (ii) Computers are capable of handling numbers and words i.e. are capable of information processing.

   (iii) Computers are capable of storing information. \(^{(162)}\)

**Evaluation**

20.11 A Philosophy for Evaluating Learning Systems

Part III is devoted to the Formative and Summative Evaluation of the educational material produced.

In discussing the philosophy for evaluating learning system a new concept is developed. Since the learning systems are understood to be dynamic in which various parts and processes are interdependent, they need to be tuned in a manner similar to other (generally physical) dynamic systems. Three main stages of tuning of learning systems were identified:
(i) The Assembly Stage

"In the system under consideration the assembly stage implies the existence of a learner, a computer program, an operational computer system and a set of instructions for the learner. In addition to that it assumes that the instructions are in a language known to the learner, that either the learner knows how to login to the machine or it is done for him, that there is enough light in the room where the learner is trying to do his 'learning' et. Most of what is required is common sense but it is possible to leave out a component rendering the system inoperative and not realise the actual cause of the ensuing chaos." (173)

(ii) The Fine Tuning

Comparison is made with the tuning of a petrol engine. "One of the most sensitive and rewarding checks is the smoothness with which the engine idles (175).

In the context of the learning system the evaluator may detect if the system is operating smoothly by just observing how the learner goes through the prescribed procedures. If he stops to look out of the window or generally is restless, then clearly the system is not running smoothly. If he asks for help too often or even once the system is not ideally tuned. What adjustments are required to bring the system up to scratch? Like for any other system, experience can advise as to what is required. Is the language slightly unfamiliar to the learner? Or is he scared of the noise the computer terminal is making? Perhaps the environment is new to him. Once again the actual technique and procedures employed are given a little later. One thing however may be pointed out at this stage. The actual tuning of the learning systems is not as simple as that of the engine. There are no screws that can be turned one way to make the content of the kit easier, for example, and turned the other way to make it more difficult. Every single change has to be made when it is not 'running' and tested again." (175)
"In the case of the engine the final test is, say, the pulling power. For the learning system this final test must be its efficacy in enabling the subjects to learn with minimum human cost. This therefore is equivalent of summative evaluation." (176)

20.12.1 The Assembly

In Chapter 12 is discussed the details of the factors which were considered during the processes to assemble the whole system. The arguments were given why the language JEAN was selected against BASIC, which seemed to have obvious advantages. The main reason was that, because of the way BASIC was organised in the University Computing Unit, "there were some errors which, when made, resulted in a 'systems response' outside BASIC. This meant that the learners were required to identify this situation, remove the error and then get back into the BASIC system" (179). This assumed systems understanding on the part of the children which they did not possess.

20.12.2 The Computer Programs

Some features of the computer program were:

(a) The parts of the programs matched with the parts of the system diagrams given. The reader can easily check this by looking at the computer programs and the kits to be found in the pocket at the back of this thesis. (180)

(b) The codes used to call the programs from the computer file indicated the objective of the programs and related well with the subject matter under discussion. (181)

(c) "One of the most rewarding activities during the development of this course was matching computing events with learning events." (181)
20.12.3 The Instruction

In a way the easiest part of assembling the course was writing the instructions in as much as there was more freedom in writing these instructions than in developing any of the other components. However, for the same reason, it was in the instructions that all the shortcomings of the other three components had to be compensated.

Strictly from the point of view of the assembly, some of the features that were borne in mind were:

(a) The language clearly had to be such that the learners related to it.

(b) The instructions matched the computer programs.

(c) The diagrams matched the instructions and the computer programs.

(d) There were sufficient instructions to proceed with the operation, such as logging in and reaching a computer program. (183)

Testing for Assembly

"If assembly is understood to mean a collection of matching components which are capable of operating together as a system, then all that was necessary to do was to check if the learners went through the 'motions' of carrying out the instructions without seeking too much help from agencies outside the system. It is of little interest to this stage of tuning whether the learners acquired any CA or not." (184)

20.13 The Tuning

"Once the system is operating the state of tuning may be assessed in two ways:

(i) Informally: by direct observation.

(ii) Formally: by measurement of various indices such as the number of times help was sought by the learner", etc. (187)
(i) Direct Observation

Based on the observation of learners using the materials, the following categories of adjustments were used:

(a) Ambiguous and misleading sentences in the instructions were changed.

(b) Excessive typing was eliminated.

(c) Instructions which went against what the learners tended to do at various stages were altered to accommodate the learners needs.

(d) The structure of computer programs was simplified, at least in those parts which the learners had to deal with directly.

(e) The diagrams of the Outline of the System was reorganised to suit the learners needs.

(f) Sample data was provided to learners every time it was required, even when the learners were given a choice to provide their own data. It was observed that when the learners were asked to provide their own data, which could be more or less any number from the top of their head, they sat there scratching it looking bewildered.

(g) Likewise, all the other supporting information was provided where and when it was needed, even if it had to be squeezed in (188).

(ii) Formal Feedback

This is discussed in the next section.

20.14 The Feedback Sheet

"The feedback procedure had two main aims:

(i) To confirm that the learning system was in a reasonable state of tuning as mentioned in the last section."
(ii) To collect factual information on the kits, such as time spent on carrying out the last set etc." (192)

A copy of the feedback sheet will be found in the appendix. It may be seen that the indices chosen for the state of tuning were:

(a) Difficulty Level
(b) Interest Level
(c) Time Taken
(d) Number of times help sought

The last index perhaps more than others gave the true state of tuning, although other indices were also useful.

20.19 The Formative Evaluation: The Results

Size of the Sample: 243

20.15.1 Number of Times help Required

The analysis showed that the mean help was sought turned out to be 0.6 times per kit. (201)

An interesting result was that there was a steady decline in the number of times help sought with rise in age. Starting with 0.8 times for 12 year olds it dropped to 0.26 for 16 year olds.

20.15.2 Time Taken to Complete a Kit

Mean time taken to complete a kit was 33 minutes. Even allowing for the time taken to settle down to the computer terminal and to wind up at the end, this time was well within the target of 1 hour for each kit set.

Once again there was a general trend downwards for the time taken to complete the kit with rise in age. (204)
20.15.3 Difficulty Level

The ideal difficulty level experienced by the learners should be 3 on a scale of 1 to 5. Otherwise they will either not care for the material or give up before completing the task. The mean level scored by the learners was 2.4 (206).

Difficulty level scored rose slightly for 12 year olds to 13 year olds then declined steadily with rise in age (208).

The difficulty level scored for various kits varied between 2.2 and 2.8 (209).

In computing difficulty level scored by the learners and the time taken to complete the kits, it was found that there was a strong positive correlation between the two (210).

20.15.4 Interest Level

Ideally of course all learners should score an interest level of 5 on a scale of 1 to 5 for all the kits. In reality, however, the mean interest level was 3.6 (211).

Mean interest level-v-age showed a slight decline from 12 years to 15 years and then a slight rise.

One of the surprising results found was that the time taken to complete a kit rose with the interest level scored (212).

The mean interest level for different kits varied between 3.4 and 3.8.

A hypothesis that to sustain maximum interest the learning task should neither be too difficult nor too easy was confirmed by the results. (216) To illustrate this result visually a 'Stereographic Histogram' is given on page 217.

The reader may like to make up his own mind if the results show that the system was reasonably tuned or not.
20.16 The Summative Evaluation

The Objectives and Procedures

In Chapter 16 is given the argument for adopting 'partially structured, open-ended interviews' for assessing the level of CA possessed by the learners after they had gone through the course. (220-225)

20.17 The Instrument of Measurement

The final objective of the summative evaluation was defined as

"This evaluation procedure will determine the level of facility to make social and general inferences on the basis of what the learner sees or hears about computers as compared to his level of facility to make inferences on the basis of what he sees or hears about situations not involving computers, possessed by him if he carries out the procedures prescribed in the course on Computer Awareness, on the scale:

<table>
<thead>
<tr>
<th>CA very much less than GA</th>
<th>CA=GA</th>
<th>CA very much greater than GA</th>
</tr>
</thead>
<tbody>
<tr>
<td>-3, -2, -1, 0, +1, +2, +3</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The instrument of measurement included the teachers, who had gone through a rigorous programme of training and a sheet of paper giving suggestions for the topics to be included in the structured part of the interviews. (228).

20.18 The Reliability of the Measurement

Chapter 17 described the method adopted to ensure the reliability of the measurements taken during the interviews. This method took the form of a training schedule lasting some six weeks in which the interviewers heard a number of recorded interviews and scored a level for CA for each of the interviews. Starting with a large scatter, the training programme improved the results to end with a bearable correspondence (240-246).
20.19 The Summative Evaluation: The Results

The sample: 
Size: 180
Valid: 170
Invalid: 10

20.19.1 Overall

Remembering that what was being assessed was the level of CA possessed by the respondent as compared to his level of General Awareness (GA) on a scale -3, -2, -1, 0, +1, +2, +3, a score of 0 would mean that CA=GA.

The mean overall score was 0.23, i.e. the learners possessed a level of CA which was marginally higher than that possessed by them for GA. This would suggest that the course probably had met the objectives (251).

20.19.2

One of the interesting discoveries made as a result of this evaluation was that where as the 7 point scale was used, nobody scored on the extreme points. "This effectively creates a 5-point scale - a confirmation that it is hard to improve on human resolution whatever devious means are employed". (254).

20.19.3 CA-V-GA by Number of Modules

The mean score for those who did only four modules was -0.22, those who did five modules 0.64, and those who did six modules 0.68. "A deduction may be made that for most learners similar to the ones in this sample, five modules will suffice - further modules to be done only by those who need extra help or those who are particularly interested in the activity". (256)

20.19.4 Contribution made by each Module

It was not easy to determine the contribution made by each module. A complex procedure was adopted to this end - even then the results only gave the comparative contribution made by each mode.
One of the most surprising findings of this evaluation was that the contribution made by the tape/slide production was negligible. (258)

20.19.5 CA-V-GA by Age

'There was a gradual decrease in the mean score of 0.73 for 12 year olds to 0.28 for the 17 year olds'. The explanation seems to be that the higher age ranges require more modules to bring their CA levels at par with their GA levels as they had longer to acquire GA. (260)

20.20 Appraisal

It is indeed very difficult to assess what a thesis might have achieved at the time it is completed. Only time can tell. An attempt was made to define and implement a new kind of teaching. Whether it will be taken up eventually, it is too early to say. The author published a number of articles and gave many papers at conferences on the work described in this thesis. The expression Computer Awareness seems to have been generally co-opted into the computing vocabulary in this country and abroad (see for example Turnbull J. J., 1974). It is not certain, however, if the spirit of the concept has been co-opted as well! In defining and implementing the new education many innovations were made, each of which needs separate evaluation. The overall evaluation carried out for this thesis only indicates that this particular arrangement of the innovations and other components show promise.

There are two directions which have to be taken as follow on from where this work leaves off: one, to develop various awareness courses and two, to try out the learning method and modify it as required. Some of the minor follow on activities include defining the conditions in which increased interest in an educational module leads to increased time taken to complete it and its consequences on learning gain. Further work is required to define operationally the concept of tuning and the way in which various dynamic processes within a learning system influence each other. Like many other research attempts before this work it raises more questions than it answers.
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