EXPLORING THE USE OF FORMATIVE MEASURES

FOR THE

COMPREHENSIVE EVALUATION

OF A

NURSING COMPUTER ASSISTED LEARNING (N-CAL) PACKAGE:

Challenging the traditional approach
to
N-CAL package construction, evaluation and use.

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Abstract

Nursing Computer Assisted Learning (N-CAL) has been described as an innovative and unique teaching method by those who have directed the development of N-CAL during the 1980s. Unfortunately, there is little evidence of this instructional technique having contributed to the education of nurses in the UK. Indeed, there is evidence of N-CAL declining in popularity. This thesis examines why N-CAL has failed to impact a nursing curriculum in the UK.

A need to change from the traditional approach to N-CAL package construction, evaluation and use is required if N-CAL is to contribute in a more significant way within a nurse education curriculum in the future. Whilst evaluation is seen as an integral element of the development of N-CAL packages a survey of existing evaluation processes of N-CAL does not reveal a strategy which could be readily applied during the production of N-CAL materials. A more exhaustive approach to evaluation, however, is utilised through the adoption of an analytical framework developed within health care itself and various measures from the field of Human-Computer Interaction are used within this framework. Evaluation methods are explored, using an N-CAL package as a vehicle, to identify the extent to which these methods provide detailed and informative information to contribute to the construction of an N-CAL package.

This thesis will report on progress towards the development of an N-CAL package which ***simulates nursing practice***, thereby exploiting the claimed potential of computers in nurse education. The development of a complex package such as this, however, requires extensive evaluation to ensure that its complexity does not interfere with the nurse learners' ability to access the information it contains. In addition, evaluation is necessary to ensure that the N-CAL package represent the nursing practice it attempts to simulate. Before complex N-CAL packages can be put in place methods of evaluating them must be first be identified.
The aim of this thesis is to extensively evaluate an N-CAL package during its production. This is an area which has largely been neglected by N-CAL and this neglect has been a contributory factor in its demise.

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Preface

What is really important in education is....that the mind is matured...

Soren Kierkegaard, Either / Or, Volume II. (quoted in Shneiderman 1987 p.357)

During the education of nurses learning becomes meaningful in the clinical environment or "real world" in which nursing is practised. It is in this situation that nurse learners can relate nursing theory to nursing practice. However, for ethical reasons nurse learners must be prepared to function appropriately within the "real world". Thus, the clinical environment of nursing is not always a suitable learning environment, for the consequences of learners actions will affect those individuals for whom they are caring.

Nursing Computer Assisted Learning (N-CAL) has the potential to simulate clinical situations which provide nurse learners with the opportunity to practise nursing within the safe environment of the classroom. N-CAL used in this way in nurse education could bring nursing theory closer to nursing practice without any risk to those individuals for whom nurses care. Indeed, nurse learners subsequent care for individuals might even be enhanced from their prior exposure to simulated practice.

Simulations of nursing using N-CAL is a goal worth striving towards. It is likely to encourage the maturing of the nurse learner's mind through their participation in a simulated "real world" from which they can learn.

This project prepares the ground for the development of complex N-CAL packages which simulate nursing practice.

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Declaration

I declare that this project and thesis is my own work carried out within the normal terms of supervision.

Chapter 1.

REVIEW OF NURSING-COMPUTER-ASSISTED LEARNING (N-CAL) AND ITS EVALUATION

Introduction

Central to this thesis is the development of an N-CAL package exploring the use of hardware and software innovations and, subsequently, evaluating techniques hitherto not found in nurse education. Consequently this chapter will critically ***review the relevant literature relating to N-CAL evaluation***. Prior to this, however, a descriptive review of the traditional approach to N-CAL implementation within nurse education will be carried out by first looking at the origins of N-CAL and tracing developments to the present day approach in the UK through two national N-CAL initiatives, one from the English National Board for Nursing and Midwifery and the other from the Scottish National Board for Nursing and Midwifery. This will include a ***review of the computing facilities chosen by nurse education***, that is the computer hardware (the physical components) and the different types of computer software (the programmes). It will also include the common use to which the computer hardware and software has been put in nurse education. In addition and in relation to this the ***perceived value of N-CAL will be reviewed,*** for an individual N-CAL programme should be consistent with the identified value of N-CAL to nurse education, and as such, this represents the most rudimentary evaluation of any N-CAL programme.

The descriptive review of N-CAL is necessary prior to the critical review of the evaluation of N-CAL, for any evaluation of N-CAL should be considered within the boundaries established by the present use of N-CAL in nurse education. It is, therefore, essential to recognise the computing facilities currently chosen within nurse education and the perceived value of using N-CAL in nurse education.

1. Origins of Computer Assisted Learning in Nursing

N-CAL originated in the US as early as 1963 when a computer-based education system, Plato (Programmed Logic for Automatic Teaching Operations), was established on main frame computers by Control Data Corporation at Mercy Hospital School of Nursing In Urbana Illinois. By 1967 students enrolled in their maternity nursing course were receiving a major portion of their instruction via Plato III. It was reported that this system forced students to be active participants in their learning both in terms of the direction of learning and the rate at which they progressed through the learning material (Bitzer and Boudreaux 1969). It has become part of the rhetoric of N-CAL that student-controlled direction and rate of learning is a desirable goal but it is a goal which is not restricted to N-CAL. The claim of student-controlled learning applies equally to learners reading a book.

During the 1970s N-CAL became popular in the USA and Canada but it was nearly two decades after the initial developments of PLATO that any national initiatives were evident for nurses in the UK. However, the Department of Education within the UK initiated a major project, the National Development Project for Computer Assisted Learning (NDPCAL) 1973-77, which produced a great deal of computer-based learning material in different areas of education (MacDonald 1977). Considerable expertise was established in the development of learning programmes using a computer, but no material for nurse education came directly from this project. It was, however, to have an indirect effect on the development of N-CAL in the following decade.

The Nightingale Project was the first dedicated nursing project in the UK established in 1982 under the leadership of Norman with joint funding from the Department of Health and Social Security and Special Trustees of St Thomas' Hospital. The origins of this project can be traced back to PLATO, for a demonstration of the PLATO education system in 1980 to individuals of the West Lambeth Health Authority was instrumental in formulating the initial framework for the project. The direction of the Nightingale Project was also greatly influenced through a study tour of the US by Norman reviewing the development and use of N-CAL in nurse education within the

US. Expertise in the area of developing the learning programme on the computer for the Nightingale Project came largely from the University of Surrey CAL group, a group carrying out research and development within CAL derived from the original NDPCAL group (Norman 1983).

During the 1980s considerable enthusiasm and interest in N-CAL as an educational innovation existed among nurse teachers and a national group known as the Network of Users of Microcomputers in Nurse Education (NUMINE) was launched in 1982 to support and channel this enthusiasm. This group recognised that nurse education faced an uphill struggle, at that time, if it were to see N-CAL included in the curriculum of a College of Nursing for, hitherto, nurse education had not been an enthusiastic receiver of the products of educational technology and the overall uptake of educational technology was disappointingly low (Pleasance 1985).

In Scotland a Computer Liason Group was established in 1983 consisting of senior nurses representing membership from each Health Board in Scotland, the National Board for Nursing Midwifery and Health Visiting (NBS), the Scottish Home and Health department, and the Common Services Agency. Computer Assisted Learning in nursing was one of the areas which this group were examining and a working group was established to explore N-CAL in nurse education (Thomson 1984). This working group identified that a great deal of individual effort and many local initiatives existed at a 'cottage industry' level. Since there was a paucity of software widely available in nurse education they considered a more centrally-led software development project a priority. Consequently, in 1985 a two year Joint Software Development Project was established with the NBS and the Scottish Microdevelopment Development Project (SMDP).

So, whilst N-CAL has its origins dating back to the early 1960s in the US it was the early 1980s before any inroads into N-CAL were apparent in the UK. Indeed, by comparison, ***N-CAL in the UK is a relatively recent innovation for it is less than ten years old.***

1.1. Terminology

The varied terminology used to describe learning materials on computers has been used interchangeably and is often a source of confusion (Hannah 1983). The following list demonstrates the range of terms which have been found in the literature.

Computer Aided Instruction (CAI)
Computer Assisted Instruction (CAI)
Computer Based Instruction (CBI)
Computer Simulated Instruction
Computer Based Education
Computer Based Training (CBT)
Computer Controlled Teaching
Automated Teaching
Computer Based Learning
Computer Managed Learning
Computer Managed Instruction

To reduce confusion it is intended to use the term Computer Assisted Learning (CAL) to include the range of educational techniques supported by a computer, and Nursing-CAL (N-CAL) when the learning material is specifically nursing-orientated. It is recognised that there is considerable semantic difference between based and assisted learning and more than a semantic difference separates learning and education from training and instruction, indeed these terms imply real variations in the level and degree of tutor and learner activity. However, Hyslop (1988) in a review of the CAL literature found that there was no consistent distinction in practise between the terminology used to describe learning programmes.

2. Present Day N-CAL

Present day N-CAL is, perhaps, best represented by the two centrally-led projects, one in Scotland and the other in England. The Scottish Council for Educational

Technology (SCET) through the Microelectronics Software Development Unit is the national body, in Scotland, which produces educational software. The Joint Software Development Project continued in Scotland 1985 - 1991 between the National Board for Nursing Midwifery and Health Visiting for Scotland (NBS) and SMDP now amalgamated with SCET. The NBS provided funds since 1987 to increase the number of full-time programmers working on this Joint Project to three managed by one of SCET's systems analysts. A steering group was subsequen tly formed consisting of members from NBS, SCET and from eight Colleges of Nursing.
The declared aims of the steering group, agreed in 1987 (Brannan 1989), were:
i) to maintain a general administrative overview of the Joint Computer Assisted Learning Project,
ii) to identify the most advantageous methods of using microcomputers, with particular regard to methodology, syllabus, and techniques of development,
iii) to initiate and coordinate the specification of N-CAL programmes,
iv) to provide opportunities to examine and critique existing software, and
v) to develop a central information service in relation to N-CAL in Scotland (Brannan 1989).

Regretfully the completion of this Joint Project in April of 1991 left the most crucial of their aims unfulfilled, for there was no statement made in terms of the most advantageous methods of using microcomputers in nurse education. Indeed, there has been little guidance given to Colleges on this fundamental issue and Colleges have been left to make their own decisions often based on scant information.

A large number of Colleges were involved and a great deal of time, resources and money was invested in this Project, but progress towards the development and completion of N-CAL programmes themselves was slow (a total of six to ten programmes were completed in the five year period). In respect of providing opportunities to examine and critique existing software, there were never any satisfactory techniques developed (this will be an area of a more detailed review later). Disappointingly the only formal evidence of the attainment of the final aim (to develop a central information service) was a document published in 1990 which listed the N-CAL programmes in use in various nursing Colleges throughout Scotland.

In terms of the declared aims of the group, this Project could not be described as successful. To some extent, however, the involvement of the College-based working parties did raise the knowledge levels of many individuals and this knowledge did begin to percolate throughout the Colleges.

Meanwhile the English National Board (ENB) had established an N-CAL Project in 1988 to run for a period of three years. The ENB N-CAL Project was a national strategy primarily directed at nurse educators, to help them identify the potential of computers and increase their awareness of the use of computers as an information tool in nurse education (Proctor 1988). To a large extent this stategy was derived from the Wessex N-CAL Project established in 1985 (Morrison and Betts 1990). As part of the ENB N-CAL Project nurse educators were required to attend one of the designated Project centres for a period of five days (Proctor 1988). Their initial training provided them with technical knowledge of the Acorn BBC microcomputer and the telecommunications network used by the Project. They were also introduced to BBC-based wordprocessing, database, and authoring software. A consolidation period of one to three months was facilitated by distance learning exercises and access to support was available via the telecommunications network offering conventional electronic mail and bulletin board utilities. The expected competences of educators having completed this training was to include technical knowledge of hardware and a sound knowledge of software including authoring tools and the ability to plan, develop and evaluate educational software.

Unexpectantly, only a third of those attending the initial training completed the distance learning, for once back in their working environment pressures of work appeared to take priority (Jupe 1990). However, networking facilities require prolonged and frequent use before users are able to take full advantage of them and given the working environment in which nurse educators find themselves it is not, perhaps, surprising that for many the initial training was not sustained.

The educational rationale behind the Project was that knowledge would be "cascaded" to all educators from those who had attended the training at the Project centres (Proctor 1988). A number of difficulties with this style of training were identified at the ENB N-CAL conference "Working IT Together" for not only is cascading akin to "chinese whispering", (Jones 1991) with a constant degradation of information with each transfer, it also requires a less fluid workforce than is normal within nurse education. Indeed, several of the initial trainees were unable to cascade for they had moved into other positions (Lyte 1991, Von-Grey 1991).

The ENB N-CAL Project's approach was entirely different to that of the NBS, for it did not aim primarily to generate N-CAL programmes. The Project's view of the technology was as an information tool not only in terms of specific learning programmes but also through software packages such as word processing, spreadsheets and databases (Proctor 1988). For their purpose the ENB N-CAL Project redefined CAL as "Learning about computers and information technology while using the technology in a planned and cognitive structure" (Proctor 1988). The definition adopted by the ENB N-CAL Project related more to Information Technology (IT, which is the use of computer science and information science to control and manipulate information) than to N-CAL itself. Regretfully, the Project directed attention away from convential N-CAL with a result that the use of N-CAL was not a fundamental area of development within nurse education in England and it has failed to impact the curriculum of nurse education to any great extent. In support of this observation, Open Software Library (OSL) the major software distributor of N-CAL packages in the UK has reported a decrease rather than an increase in sales of N-CAL programmes in the last two years. This lack of impact was further demonstrated at the ENB N-CAL conference "Working IT Together" in March 1991 which marked the end of the Project. At that conference traditional N-CAL was formally represented by Microtext authoring (Proctor et al 1991, Jones 1991) which is a rudimentary authoring software package and has long been overtaken by more powerful, flexible and easier used authoring tools. Sadly, this level of N-CAL presentation at this National conference indicates the poor level at which N-CAL exists within the UK.

Internationally, the development of N-CAL continues with new technologies being explored - for example, at the Nursing Informatics '91 "The Fourth International Conference on Nursing Use of Computers and Information Science" more advanced authoring tools were demonstrated (Hypercard by McCormac and Jones 1991 as well as Zelmer et al 1991 and others, and PROPI by Slaughter 1991). The development of expert learning programmes (Koch and McGovern 1991) was demonstrated and multi-media technology for education was also demonstrated and reported (Engberg and White 1991). An exciting collaboration between a College of Nursing and a hospital in the US sharing the same computing resource was reported by Grassy (1991) where learners were able to access patient databases and develop care plans validating them against those developed by practising nurses. The progress in the development of N-CAL reported at this International conference is a testimony to the real potential of N-CAL and it is within this context that N-CAL in the UK should be judged.

The two central initiatives in the UK have been partially successful, perhaps, in raising an awareness among educators of the potential use of computing facilities in nurse education. Unfortunately, N-CAL in the form of dedicated learning programmes, particularly in England, has been neglected. Internationally, however, major strides in this area are evident.

The following sections will review the computing facilities chosen by nurse education in the UK, for it is through the use of these facilities that N-CAL derives its constaints.

2.1. Computing Facilities in Nurse Education.

Computing facilities can be represented by:

i) the hardware that is the physical components and

ii) the software or programmes.

The two are integrated, for having chosen to use specific hardware the choice of software will be restricted or vice versa. Thus the computing facilities chosen by nurse education will determine the potential use of N-CAL. This section is designed to illustrate the facilities chosen by nurse education in the UK so that an understanding of the actual and potential use of N-CAL within nurse education will be gained.

2.1.1. Hardware

The earliest N-CAL programmes (PLATO) used a CDC 1604 mainframe computer (a bulky expensive commodity) with seventy student terminals connected (Bitzer and Boudreaux 1969). Today the microcomputer has become as powerful but sits conveniently on the desk top at a fraction of the cost. Indeed an updated version of the PLATO programme has now been written for the microcomputer (Day and Payne 1987).

N-CAL in the UK, being a fairly recent innovation, has always been developed on the microcomputer, originally the Acorn BBC B. This was the microcomputer used by the Nightingale Project (Norman et al 1988) and the predominant hardware in schools of nursing in the UK for educational use continues to be the Acorn BBC microcomputer. It was also the machine on which the NBS/SCET Project chose to standardise in Scotland, in common with the Wessex N-CAL Project in 1985. It continues to be the machine which the ENB N-CAL Project has indicated will be the 'workhorse' of educational computing in the immediate future (Proctor 1988).

There is, however, growing dissatisfaction with the BBC, for it does not compare favorably with the power and flexibility available from the wide range of current low cost micros. The SCET programmers reported difficulty with 'shoehorning' increasingly more complex programmes, desired by educationalist, into the 'tiny memory' of the BBC (Brannan 1989). Whilst it might be possible to overcome this criticism by increasing the the memory of the BBC, programmes are written for the standard equipment in general use and as such the 'tiny memory' referred to by SCET programmers is a restriction on the development of N-CAL programmes if they are designed to be used widely in nurse education. The Acorn BBC is not the computer hardware of choice for the future. Indeed, the Wessex N-CAL Project are now basing their educational programmes around MS-DOS PC computers, and the ENB N-CAL Project has recommended a move towards the Acorn Archimedes computer system in the future. In Scotland there are several Nursing Colleges now using Apple Macintosh computers and within general education there are many examples in schools within the two major regions Strathclyde and Lothian using the Apple Macintosh range of computers to teach higher level computer science. The NBS recommended two computers i) the Acorn Archimedes and ii) the Apple Macintosh range of computers and a document was circulated to Colleges which attempted to compare the two machines and their peripherals and included a review of available software (Monfries 1991). There were, however, a number of difficulties with the document for a comparison was made between dissimilar hardware and software. In particular, the software reviewed for the Apple Macintosh range of computers represented a much greater functionality than the software reviewed for the Acorn Archimedes computers and, as a result, the comparison of cost for such software was quite inappropriate for it did not compare like with like.

What is surprising about the recommendations from the National Projects in Scotland and England has been the absence of any recommendation for the PC range of computers (MS DOS compatible), for these represent the standard facility used by many Health Boards in Scotland and Health Authorities in England and, as a result, many Nursing Information Systems utilise this standard. There were reports at the ENB conference 1991 "Working IT Together" of Nursing Colleges in England standardising on PC or compatible equipment and suites of PCs are in evidence in a few Colleges (Lyte 1991, Bucklitch 1991, Jones S. 1991). It is of little consequence to nurse education that the Acorn Archimedes is capable of emulating MS DOS, for the emulation process slows the functional capabilities of any package which runs under MS DOS. Thus, the emulation is limited.

The amount of computer hardware available within Colleges of Nursing will have a large effect upon the widespread use of N-CAL in a nursing curriculum and the number of computers available in different Colleges of Nursing varies considerably. It is difficult to get accurate information across the UK, but in Scotland one of the richest Colleges in terms of available computing hardware has a total of twenty one microcomputers whereas the poorest have three. Few Colleges of Nursing have dedicated computer laboratories, although they are becoming more prominent for a number of Colleges in England reported at the ENB N-CAL conference of utilising this kind of facility (Lyte 1991, Snashall 1991).

Whilst the UK experience of using N-CAL is, by comparison to the US, in its relative infancy it does have a history of nearly ten years which, in terms of the technology available then and now, is a period of time during which unprecedented advances have been made none of which have impacted nurse education (this is a statement which will be clarified in Chapter 2). Nurse education has persisted with the aging Acorn BBC microcomputer into the 1990s even though it has been superseded by more powerful and flexible microcomputers which represent 1980s technology.
Having established the hardware chosen by nurse education this determines the software available to nurse education and this will be reviewed in the next section.

2.1.2. Software

The majority of programmes for nurse education in the UK have been written in the language BASIC by professional programmers and more recently there has been an increase in the use of authoring software by educationalists writing their own material using software such as MICROTEXT or TOPCLASS. Both of these routes are restrictive in terms of development when compared with more recently developed alternatives.

The first option - professional programmers wrote in BASIC, was the method utilised by the NBS / SCET Joint Project and the Nightingale Project which resulted in a slow rate of progress towards achieving the finished N-CAL programmes. In addition the language BASIC is cumbersome and time consuming and at best the N-CAL programmes have been mainly textual with chunky graphics. The second option - educationalists used authoring tools, was speedier and educationalists were less reliant on others. Unfortunately, the authoring tools used are themselves restrictive in terms of the presentation of the N-CAL programmes and the results have been no better and often worse than those produced using the language BASIC. The next section is designed to examine how these facilities are used within the curriculum of nurse education.

2.1.3. Use of N-CAL

The design of N-CAL programmes or what they attempt to do have varied considerably and attempts have been made to classify them. The commonly-cited classifications of N-CAL include drill and practice, tutorial, problem solving, and simulation (Hasset 1984).

Drill and Practice are the most commonly-found learning programmes and are often little more than electronic page turners where a question is presented to the learner and feedback is given following the learner's response. **Tutorials** are an extension of the drill and practice routines but provide more instruction and feedback. They tend to use branching techniques to enable the learner to move quickly on to more advanced levels or back for remedial teaching dependent on their response. **Problem solving** instruction on the computer uses the unique ability of the computer for information retrieval in solving specific discipline orientated problems by utilising a large store of information from which the correct answers can be gleaned.

Simulation programmes are designed to simulate common clinical situations, the user interacts with the learning programme and the consequences of their actions are reported by their progress through the learning programme. Learners should learn from their mistakes during simulated realistic situations whilst remaining within the safe and controlled environment of the classroom and without risks to patients. The greatest potential for learning from a computer is reported to be learning programmes which combine problem solving and simulations of nursing practice (Norman 1988). These N-CAL programmes closely relate to meaningful experiential learning where the learner is actively involved and learning is relevant (Rogers 1969).

Other classification schemes exist within CAL, but Hyslop in his review of N-CAL (1988) concluded that there was no single classification scheme which offered an adequate framework within which a specific N-CAL programme could be reviewed, for he found that most programmes fell into more than one of the classification schemes regardless of which one is used.

In practise a description of an N-CAL programme is needed and the categories offer a guide to educators when making a decision about their potential value. Even if the programme falls into more than one of the above categories it does provide information which enables rationale decisions to be reached by educators.

Several sources of N-CAL programme listings are available, but unfortunately, they do not always give adequate information about individual programmes. For example, the NBS list of software available from Caroline Lindsay, Educational Officer, includes programmes which are in place in at least one of the Colleges of Nursing in Scotland. Ten of the programmes were prepared by NBS / SCET, although four are reported to be on trial, fourteen from Garland computing, twenty packages prepared in-house, and a large number from Open Software Library (OSL) and others. Unfortunately no attempt was made to categorise the programmes on this list nor were the programmes described in any way. OSL produce their own software catalogue containing over fifty programmes covering a wide variety of subjects and this list does provide a brief description of the programmes. A new source of information is the Cumulative Index for Nursing and Allied Health Literature (CINAHL), an international database which now includes abstracts of N-CAL programmes as they are released. Finally, there is a yearly publication from the USA known as the Directory of Educational Software for Nursing at a cost of seventy nine dollars which contains detailed descriptions of over four hundred and fifty programmes for the IBM and Apple Macintosh (Bolwell 1991).

Whilst flamboyant promises have been made of N-CAL, in practise a closer look at the programmes available in the UK reveals rudimentary N-CAL programmes often little more than electronic page turners (Proctor 1988) and, as such, promises remain to be fulfilled. In addition, the catalogues of N-CAL programmes lists a random pecking of unconnected topics from a nursing curriculum. Hannah commented at the ENB N-CAL conference "Working IT Together" that "educators do not use rational means for selecting appropriate topics for N-CAL lessons" (Jones 1991).

For nurse education to have persisted with the aging Acorn BBC has resulted in the potential of N-CAL being restricted. Having chosen the Acorn BBC the result of that choice in terms of available software, both N-CAL programmes and authoring tools, has been severely limited. ***It is clearly seen from this descriptive review of the computing facilities available in the UK that N-CAL exists only in a rudimentary and fragmentary form.***
The number of computers available within nurse education is a sure indication of computer use in a curriculum of nurse education, for a College which has twenty computers with an intake of sixty students four times a year will be unable to integrate computer use to any large extent into the curriculum. One study, completed in a College of Nursing in Scotland which has access to the greatest number of computers among Colleges, identified that a mere total of eleven hours were spent in using the computer throughout the learners training. This period of time represents 1.5% of the total time allocated to nurse education theory (Khan 1990).
The activity at the computer is seen in Colleges of Nursing to be a group activity. In the study referred to above the number of learners in a group ranged from three to eight learners at one computer (Khan 1990). It is a similar picture throughout Scotland and the UK, although precise figures are not available.

At the time of writing the total time a nurse learner spends at the computer during their nurse education is insignificant and the time they spend using N-CAL is even smaller. Nurse education, however, is in a state of change (the Implementation of Project 2000

represents a complete curriculum review) and attempts have been made in England to increase the number of hours learners spend using computing facilities and there are proposals to increase the number of hours in Scotland. It is clear that the extent to which N-CAL and IT will be integrated into the nursing curriculum under Project 2000 (already in place in England and due to commence in 1992 in Scotland) requires significantly more integration than is seen in Colleges of Nursing today. It is not clear, however, how this will be realised. Many attempts have been made by Colleges to introduce 'computer awareness' into the nursing curriculum under the guise of various software packages such as wordprocessing, spreadsheet, database, desk top publishing or even statistical packages. However, hands-on experience covered by 'computer awareness' may be quite irrelevent to nurse education (Hoy 1991).
Whilst the time learners spend using computing facilities is not restricted to the use of N-CAL there is no doubt that this method of teaching can play an important part in the curriculum but ***N-CAL packages of quality which address issues central to the nursing profession need to be put in place*** and for this to be satisfactorily achieved the computing facilities available to nurse education need to be improved.

2.2. The Value of N-CAL

The educational value of using the computer must be consistent with its use as a tool by which learners can achieve educational objectives (Ellis 1974). However, although the achievement of educational objectives is important, the value of using computers within education extends beyond its educational value, for computers are now in common use in our daily lives. For example, supermarkets, banks, transport systems (road, rail and air travel) provide constant evidence of there value in society. Indeed Stonier (1988) recognised that "Information Technology is invading every aspect of work (and life) - health care is no exception". Educational practices are influenced by social values - for example, the director of the Microelectronic Education Programme (MEP a major national project initiated by the department of education in 1980) stated the aim of the project was to "help schools prepare children for life in a society in which devices and systems based on microelectronics are commonplace and pervasive" (Watson 1987). Computers are commonly used by nurses to monitor patients (Taylor et al 1989, Tait et al 1991), prepare and write a Nursing Care Plan (Mingay 1991, Von Grey 1991), and in the management of nursing (Swift and Jordan 1989, Lubno 1991).

Looking to the future, nurses, as health care providers, will be accountable for the services they provide (Information Management Group of the NHS Management Executive 1990). Accurate and timely documention of nursing activities and the appropriate allocation of skilled nurses moves towards greater accountability within the nursing service. Ward Based Nursing Information Systems on computer workstations include elements of care planning, rostering, accountablity, workload estimation, costing and auditing and the extent to which nurses will utilise this technology is set to increase. ***Nurse learners should be prepared, through education, to take advantage of the technology used by nurses.***

The usefulness of N-CAL has been identified in terms of its value ***socially***, ***professionally***, and ***educationally*** (Billings 1984). Indeed Norman (1988) reiterated the potential meaning of N-CAL to education not just as an educational tool but as a "..valid tool for achieving desired outcomes in professional practice, with the additional benefit of exposure to an important cultural revolution".

Unfortunately the present computing facilities widely chosen in nurse education are limiting the social and professional value of N-CAL. For, learning about the functionalities of computing using the Acorn BBC is akin to learning to drive using a tractor. Just as there are some vague similarities between driving a tractor and driving a car, equally there are some vague similarities between the functionalities offered by the Acorn BBC and contemporary computing facilities but those offered by the Acorn BBC are limited, difficult to learn and difficult to use. No one would consider driving any distance using a tractor, neither is the BBC used in any serious way in society or more importantly by the nursing profession. ***The present computing facilities widely chosen by nurse education are restricting the very nature of N-CAL programmes.*** Authors have been confined to utilising programming languages or tools which are severly limited and cumbersome and this is reflected in the quality of the programmes available. Few N-CAL programmes claim to simulate professional nursing practice and where this has been attempted it has only been achieved in a rudimentary form. As a result nurse learners are not being prepared through existing N-CAL programmes for a professional nursing practice which utilises computers. ***It must be concluded, therefore, that the social and professional value of using N-CAL in nurse education is being severly limited and the present use of N-CAL in nurse education is unable to realise its potential educational value.***

Having identified the limitations which surround N-CAL in the UK it remains to be seen how N-CAL has been more formally evaluated by those who are at the centre of N-CAL production, development and promotion. It is claimed that the evaluation of N-CAL is a necessary and important process, (Norman et al 1988, ENB CAL Project Framework 1988) and others have reported it as the most important process in the design of N-CAL (Stewart et al 1988, Thomson 1990). The section below is intended to comprehensively review the methods used to date to evaluate N-CAL.

3. Methods used to Evaluate N-CAL Programmes

The following section will critically review those studies which represent the evaluation of N-CAL. This will include an exhaustive review of the methods which have been used to evaluate N-CAL programmes in the UK. Sadly, there are few studies which have been completed within the UK and as such it is intended to more widely illustrate methods of evaluating N-CAL by including studies from other countries and additional examples from the general education sector. It is not intended to be an exhaustive review of all evaluation studies of N-CAL programmes for the results of many of the studies completed particularly in the US are not directly applicable to the UK experience (in the US the hardware and software available is quite different to the UK). However, it will include all those studies which have been completed in the UK.

Various evaluation methods are reported to have been used such as paper and pencil instruments, observational techniques, interviews, and computer captured data (Benton 1988).

Paper and pencil instruments have been widely used in a variety of forms to gather information. Achievement questionnaires and attitudinal questionnaires are the most common examples (Allen 1988, Bitzer and Boudreaux 1969, Conklin 1983, Huckabay 1979, Stewart et al 1988, Norman et al 1988, ENB CAL Project 1988).

Observational techniques have not been used extensively in the evaluation of learning material for they are claimed to be labour intensive and produce low yields for the time and costs involved (Bigum and Gilding 1980). Benton (1988) in a study in the UK used observational techniques when he recorded on video the interaction which occurred between the user and the computer in an attempt to determine the cognitive functionings of subjects, but insufficient data was gathered to enable an analysis. Within general education Laurilland (1978) used direct observation when she attempted to classify learners behavior at the computer and others have reported methods of recording the interaction between the user and the CAL programme for analysis at a later date (Della-Piana 1982, Dwyer and Crtichfield 1972).

Interviews have been used in a structured or semi-structured format enabling feedback from users. Benton (1988) used this technique but was careful to acknowledge that the success of this method was dependent upon the ability of the researcher to interview in a non-directive manner and to recall the information imparted accurately. Norman et al (1988) also used this technique when evaluating an N-CAL programme produced from the Nightingale project but ensured accurate recall of information by recording the interviews.

Minimal **computer captured data** has been used, most often this has been the results of tests administered during a learning programme but it has also included demographic data and the results of open ended questioning (Norman et al 1988, Vasek and Volger 1984).

Hazen (1980) reviewed evaluation methods of CAL in the general education sector including: examinations and attitude questionnaires, observational methods, archival and interview methods and concluded that ***no single measurement method is satisfactory by itself***. Unfortunately within N-CAL evaluation there are many examples where there has been little attention paid to this and, as a result, conclusions in relation to N-CAL have been reached on the basis of insufficient data (reference to this will be made later).

Innapropriate conclusions have also been reached when insufficient care has been taken to ensure that the N-CAL programme itself is of quality - see Brudenell (1990) and Day and Payne (1987) for examples of this. Schleutermann et al (1983) recognised that inefficiencies and errors in an N-CAL programme may interfere with learning and in an effort to combat this a distinction has been made between formative and summative evaluation. This distinction came from general education where changes in the curriculum much more fundamental than CAL were being examined. Scriven (1967) described ***formative evaluation*** as that which was used while the learning programme was still fluid and ***summative evaluation*** as that which appraises the learning programme on the market.

The majority of evaluation studies of N-CAL have been summative attempting to measure the ***effectiveness*** of N-CAL and it is with this form of evaluation that the review will start.

3.1. Summative evaluation

Typically, summative or outcome evaluation yields information about the impact of the programme once it is available for widespread use. There has been descriptions in the literature of how summative evaluation has been achieved and the following sections will review the summative evaluation of N-CAL programmes in relation to its effectiveness defined in four different ways :

i) attitudes towards specific N-CAL programmes and N-CAL in general,
ii) amount of time spent using the learning programmes,
iii) achievement on examinations and
iv) ability to transfer knowledge

Studies will be reviewed in relation to each of these areas in turn.

3.1.1 Attitude towards specific N-CAL programmes and N-CAL in general

Instruments which are reported to estimate attitudinal response are fairly common and there are two methods which have been used extensively. A semantic differential tool, first produced by Osgood et al (1957) for measuring the psychological meaning of a concept, requires the subject to choose an adjective which best describes their attitude towards N-CAL. Allen (1989), Brudenell et al (1990), Conklin (1983), Hamby (1986), Gaston (1988), Day and Payne (1987), have all used a revised differential tool to measure learners attitudes towards N-CAL in general. Alternatively a questionnaire constructed on a Likert type rating scale produced by Huckabay et al (1979) has been used by Neil (1985) and Benton (1988) to measure attitudes towards a specific N-CAL programme. Results of applying these instruments have reported learners' attitudes towards N-CAL as an instructional medium to be comparable or more positive than traditional teaching methods (Benton 1988, Gaston 1988, Hamby 1986, and Neil 1985). Belfry and Winnie (1988) reviewed N-CAL evaluation (mainly US studies) and found reliably more positive attitudes in nine out of the eleven studies.

Kirchoff and Holzemer (1979) correlated the results of an attitudinal questionnaire with biographical data and reported that subjects were more likely to have positive attitudes when they had concurrent clinical experience related to the topic of instruction and when they perceived the N-CAL programme as meaningful.

More recently there have been two notable exceptions to the results reporting comparable or more positive attitudes towards N-CAL. Day and Payne (1987), and Brudenell (1990), reported the subjects in their studies demonstrated significantly less positive attitudes towards N-CAL following exposure to this method of study. Both of these studies concluded that the inconsistency of their findings with others could be attributed to a poor quality of the learning programme under review.

The study by Benton (1988), completed in the UK, used a total of fifty five subjects divided into three subject groups - a control group received no instructional input, a traditional group received instruction via a lecture / discussion and an experimental group received instruction using an N-CAL programme prepared by the author. He used a Likert type rating scale to measure subjects attitudes towards the different teaching media, N-CAL and lecture / discussion. Benton reported a significant difference between the groups with more positive attitudes reported towards the N-CAL media. He also used open ended questioning to elicit a more complete picture of users attitudes towards N-CAL. Six open ended questions were posed to the experimental group and an analysis of the comments were summarised in terms of those features which subjects liked most. It was reported that subjects liked i) learning at their own pace (subjects in this experiment used the N-CAL programme on their own), ii) privacy when learning, iii) the ease with which they were able to use the N-CAL programme, iv) the reinforcement received from the N-CAL package and v) active involvement in their learning using the N-CAL package. Those features which the subjects liked least included i) using a typewriter keyboard, and ii) the inability to move back in the programme.

In the UK, qualitative subjective data was gathered by Stewart et al (1988) from learner users in an attempt to identify their reaction to and perception of N-CAL. They identified, from questionnaires completed by 100 student nurses using different N-CAL programmes, various features which the learners liked or disliked or which they felt added to or detracted from N-CAL programmes. Learners included interactive, self-pacing and immediate feedback as important features which they felt added to the programmes functionality whilst lengthy documentation, inconsistency in the way they were requested to respond whilst using N-CAL and lack of choice detracted from the programmes functionality.
Authors of learning programmes should find these results and those reported by Benton (1988) useful when considering the presentation of learning programmes.

Again in the UK the Nightingale project was extended to illuminate the potential contribution of N-CAL to nurse education as perceived by learners. For this purpose, information was gathered from questionnaires, structured interviews and computer captured data to assess user reaction to the N-CAL programme developed by this project (Norman et al 1988). A total of one hundred and thirty six volunteers from three different hospital sites were used as subjects.
A questionnaire was administered and completed by subjects on completion of the N-CAL programme to elicit information in relation to their previous experience and opinions of the N-CAL programme. A five point graphic rating scale was used to determine subjects responses to various aspects of the N-CAL programme including screen presentation, programme instructions, relevance of content, the value of the programme and overall enjoyment and understanding. In addition, a structured interview was used to elicit more information in relation to questions asked in the questionnaire. The interviews were recorded. The N-CAL programme used both free text entry and multiple choice to elicit information from subjects. Ninety six percent of

the subjects reported difficulty, recorded on the questionnaire, with the free text entry section and at the interview sixty one percent of the subjects reported that they were frustrated / angry or annoyed / irritated by the computer screens response "Sorry no match found" (this was in response to free text entered which was not recognised by the computer). At the interview subjects were asked for their reaction to the free text entry section and it was reported that seventy percent of the replies related to "...harder, but better for you.......good because it makes you think...". This was reported, quite inappropriately, as a preference for "active unprompted thinking". If a preference was recorded it was more objectively recorded in the questionnaire where sixty nine percent of the of all subjects rated their enjoyment high for the multiple choice section, whilst only fifty seven percent of all subjects rated the free text entry section section high. The learning experience was reported in the summary to have achieved a high degree of user acceptability and the overall perceptions of the subjects to the N-CAL programme were reported to be positive. The overwhelming proportion of comments as to the potential benefits of N-CAL were also reported as positive. Benefits of N-CAL were identified by subjects as self initiated independent study (subjects used the N-CAL programme on their own). It was concluded that the successful utilisation of N-CAL depends heavily on the standard of software development and whilst the subject's immediate response appear to have been positive there were fundamental difficulties identified with the N-CAL programme as an information tool and this has restricted its widespread use.

The most common method of evaluating N-CAL in the UK is through the use of a checklist of the type suggested by the ENB N-CAL Project (1988) or a checklist of the type used in general education developed by Preece and Jones (1985). This form of checklist records the attitudes of educationalists towards a specific N-CAL programme. The educationalist assessing an N-CAL programme is asked to comment on features of the programme. For example, educationalists have been asked to give their opinions in relation to accompanying documentation or support material, the accuracy and the presentation of the N-CAL programme and its appropriate use in the curriculum of nurse education. Preece and Jones found that "educationalists were not very critical during their assessment of CAL programmes," and they reported educationalists often giving higher ratings in a summary which did not then correspond

to the ratings given to individual features for the same programme. The ENB N-CAL Project has reported, however, that it has been possible to set "national standards" for the assessment of learning programmes through the use of their Assessment Tool (ENB CAL Project 1988).
Decisions have been made, using the ENB N-CAL Project's Assessment Tool, about the value and use of individual N-CAL programmes on the basis of the opinions from, at most, two or three educationalists and whilst educationalists were asked to observe learners using the N-CAL programme under evaluation and make comment about its usability, opinions are likely to have been formed as a result of isolated incidents. Although this kind of evaluation is valuable in focusing attention on specific aspects of an N-CAL programme, it is not on its own a satisfactory method of evaluating N-CAL material, for it relies on subjective statements and the interpretation of individual educationalists. It is difficult to imagine "national standards" being achieved when the opinions given by an individual educationalists in the study reported by Preece and Jones were often seen to be conflicting. This form of evaluation is based on insufficient information for, not only is insufficient data collected, but in addition only one method of collecting the data is used. Information such as this would be more valuable if it were used in conjunction with data obtained from learner users.

User attitudes are comparable or more positive towards N-CAL in general as a teaching medium, where results have been to the contrary this has been attributed to the poor quality of the learning programme under review.
Several different features of specific N-CAL programmes have been identified which encourage more positive attitudes. These include self-initiated, independent learning at the users' own pace. Unfortunately the present use of N-CAL in a nursing curriculum in the UK does not enable these benefits to be realised for N-CAL is a group activity. In addition the N-CAL programmes must be meaningful.
Finally, the current use of checklists by educationalists is not seen to be a satisfactory method of assessing N-CAL programmes.
Whilst attitudes are positive it cannot be described as a measure of N-CAL's ***effectiveness*** for what is liked most is not always what is educationally best. Attitudes are influenced by a number of indeterminates (Benton 1988, Jones and McCormac in press) and both novelty engendering effects and anxiety provoking

effects have been claimed to be a result of users utilising N-CAL (Norman 1988). More objective summative measures are needed to determine the effectiveness of N-CAL.

3.1.2. Amount of time spent using an N-CAL Programme

Time has been used as a summative measure of N-CAL's effectiveness by comparing the time spent by a group of learners completing an N-CAL programme to the time spent by a control group of learners using an alternative teaching method.
Bitzer and Boudreaux (1969) used this method and demonstrated that learners took one third to one half the time to meet the educational aims and objectives when using the N-CAL programme PLATO compared to a lecture discussion.

Similar time savings were reported by Benton (1988) in the UK using a small group of post registered nurses utilising computing facilities individually. The average completion time of the N-CAL programme by the group in Bentons' study took seventy one percent of the time taken by the group receiving their instruction by a more traditional teaching method (in his study a lecture / discussion group was used). However, these results are not as straightforward as they would appear, for subjects in Bentons' study took from forty five percent to one hundred and eight percent of the time taken by those subjects who completed the same learning experience via the one hour lecture / discussion. Benton recognised that educationalists could easily be misled by results if learning schedules were based on mean times. He believed that times should be based on the mean plus two standard deviations to take account of ninety five percent of all learners. His is own study, when taken in this context, reveals a time of sixty five and one twelfth minutes for the majority of the subjects (ninety five percent), ***demonstrating that N-CAL was not as time efficient as the lecture medium***, since all subjects completed the lecture in sixty minutes.

Day and Payne (1987) reported learners spending considerably more time on N-CAL than a lecture to meet the same objectives. In this study the times were estimated by the learners in a learning log. The learners reported spending two hundred and twenty three minutes meeting objectives on the computer in contrast to one hundred and thirty eight minutes meeting the objectives by lecture. Clearly, ***the results of time***

savings when N-CAL is used are inconclusive.
The review will now examine the research in relation to N-CAL's effectiveness as determined by a measure of the learner's achievement.

3.1.3. Achievement in Examinations

N-CAL is primarly about the achievement of educational objectives (Ellis 1974) therefore, summative evaluation as determined by achievement tests would appear to offer the most appropriate information as to its effectiveness. Achievement has typically been determined by knowledge gain and the most commonly used method has been a pre- and post-test design where the user's level of knowledge was established prior to the learning experience and knowledge gain was tested following the learning experience.

This method was used in the evaluation of the Nightingale Project (Norman et al 1988) where subjects were given a fixed choice response test (that is true or false responses and some multiple choice responses) prior to commencing the N-CAL programme. The purpose of the pre-test was to identify the subjects' level of knowledge prior to commencing the N-CAL programme. An identical post-test was given to the subjects immediately after they had completed the N-CAL programme to determine their level of knowledge after using the N-CAL programme. It was reported that sixty percent of the subjects scored higher (an average of a ten percent increase) in the post-test than in the pre-test. However, this result was not statistically significant, indeed, this represented an average increase of only two questions from a total of nineteen to twenty five questions.
Subject's scores in two different sections of the N-CAL programme (free text entry and multiple choice questions) were recorded by the computer and this data was used as an assessment of the subjects' performance during the programme. The data collected here was correlated with some of the biographical data obtained from the questionnaires. For example, it was surprising that those subjects with previous training in the programme's content did not score significantly different in the free text entry section of the programme to those with no previous training. However, there was a significant difference in the scores obtained by those subjects with previous computer experience in this section. This would suggest that the programme's

functionality interfered with its use as an information tool, for information should be readily input into the computer as well as accessed from the computer. This point was clearly demonstrated when during the multiple choice questioning in the programme those subjects with previous training in the information content scored better than those without previous training.

For those subjects with previous training in the nursing information contained within the N-CAL programme not to have scored better than those with no previous training would suggest that the ***N-CAL programme failed as an information tool*** during the free text entry section of the N-CAL programme. Previous training in the information that the N-CAL programme was designed to enhance should have had a significant bearing (and did have a significant bearing when the N-CAL programme's functionality was changed to multiple choice selection) on the subjects' performance in answering questions during the N-CAL programme.

It was recognised that the free text entry section of the N-CAL programme needed to be more flexible, for subjects spent time and cognitive effort diverted from the main task of analytical information gathering to finding the right word acceptable to the N-CAL programme.

Whilst it was reported that subjects improved their knowledge, this was not found to be a significant improvement. Had the results been significant it would only have indicated a short term knowledge gain. Many expressions of intention to alter practice were made during the interviews but there was no objective data gathered to support an effect having been elicited from the programme.

Other studies have attempted to evaluate the effectiveness of an N-CAL programme as determined by achievement compared with that of a more traditional teaching method. N-CAL is claimed to be at least as effective as traditional methods of teaching in achieving cognitive gains (Benton 1988, Day and Payne 1987, Gaston 1988, Hamby 1986, and Neil 1985). However, only one of these studies (Benton) reported a significant difference between the traditional method and N-CAL. In addition, all the studies measuring user achievement on examinations in a review paper (Belfry and Winnie 1988) reported better results when N-CAL was used but only four studies reported significant differences between N-CAL and traditional methods.

Studies reporting the relative effectiveness of N-CAL in comparison to a traditional teaching method by assessing learners' cognition appear to offer the most useful information to enable educationalists to make decisions about the appropriate use of N-CAL in the curriculum. However, there are a number of difficulties with this type of evaluation and one of the difficulties comes from ensuring that the teaching methods are, indeed, comparable. In the study reported by Benton (1988) subjects using the N-CAL programme were given the opportunity to correct answers, whereas no such facility was afforded to the group in the lecture / discussion. Indeed, the two methods were not really comparable despite considerable efforts by the author to ensure the equivalence of the material presented by setting objectives for the lecture / discussion group identical to those set for the group receiving their instruction using N-CAL and sitting in on all lectures to ensure the objectives were met. The N-CAL programme utilised by Benton (1988) in his study was of a drill and practise type presenting mainly factual information from which learning was easily examined. Whilst, the significantly different cognitive gains experienced by the N-CAL group in Benton's study is impressive Benton himself warned against generalising these results to N-CAL for he believed them to be a function of the specific N-CAL programme under evaluation.

In studies such as these it is difficult to imagine what could reasonably be described as a comparable teaching method. Other studies (Neil 1983, and three of the studies reported in the review paper by Belfry and Winnie 1988) used reading material as the traditional method of teaching against which N-CAL was compared but no attempt had been made to ascertain whether the reading material had actually been read. Many studies (Benton 1988, Day and Payne 1987, Hamby 1986 and five of the studies reported by Belfry and Winnie 1988) have used the lecture as a traditional teaching method against which N-CAL has been compared but a lecture is ephemeral, for once given its content cannot be reviewed by learners in the same way that an N-CAL programme can be reviewed.

An additional difficulty in evaluating the relative effectiveness of N-CAL in comparison with a traditional teaching method comes from the pre- and post-test design. If the same questionnaire is used before and after the learning experience, there is a difficulty ensuring that subjects do not become sensitised to the questionnaire. The studies referred to above, with the exception of Benton (1988) and

Conklin (1983), made no attempt to measure the effect from sensitisation to the questionnaire.

In the Canadian study reported by Conklin (1983) a total of thirty four subjects were used in three groups. The control group did not receive any instruction, a traditional group were assigned reference-reading representing a traditional teaching approach and the experimental group were assigned the reference-reading material but in addition were also assigned the N-CAL programme. Pre-testing and post-testing occurred six weeks apart during which time both the experimental and the traditional group were exposed to nursing experience relevant to the questionnaire but the control group were not exposed to any relevant nursing experience. The purpose of the control group was to test for learning as a result of cues in the pre-test and to control for any incidental learning which might have occurred in the six week interval between pre-testing and post-testing.

There was a significant improvement on the post-test scores in comparison with the pre-test scores reported for the experimental group and there was no significant improvement between the pre-test scores and the post-test scores for either the traditional group or the control group. It was concluded that N-CAL greatly enhanced the learning process in this experiment.

It should be noted that this study utilised ***N-CAL as an additional learning opportunity***, for it did not compare N-CAL with traditional teaching but examined the effect of utilising N-CAL alongside an existing teaching method. Indeed the author's view of N-CAL was to augment traditional instruction.

In the study reported by Benton (1988) a significant difference was identified between the pre- and post-test scores of both the traditional and experimental groups and there was no significant effect in the control group from having taken the test twice. Benton concluded that users did not become sensitised to the test.

Pre- and post-tests measure instant recall of knowledge it is thus appropriate to measure whether or not any knowledge gain will be retained over a period of time.

It is disappointing that only two studies have been found in the literature review which have attempted to measure a retention of knowledge and this has been tested by giving the learners a post-test after a period of time has elapsed. The period of time elapsed before further testing has varied from eleven weeks to eight months (Boettcher et al 1981, and Gaston 1988). No significant difference in retention of knowledge were found where N-CAL was compared with a traditional teaching method.

It must be concluded that the results of ***N-CALs' effectiveness in terms of achievement are not as straightforward as the literature would suggest.*** A number of difficulties have been identified with the evaluation methods not least of which is the pre-and post-test design for measuring knowledge gain. Finally, it is difficult to imagine what could be described as a comparable teaching method, and the studies which have attempted to compare N-CAL to a traditional method of teaching have failed in this respect.

3.1.4. Ability to transfer knowledge

Finally, the summative evaluation of N-CAL's effectiveness has attempted to measure whether learners are able to apply any knowledge gained from an N-CAL programme. Application or transfer of knowledge has been measured by a learner's ability to use the learned material in new situations. However, this has not been attempted within a practical situation for this is an extremely complex task. The method used to measure a learner's ability to transfer knowledge has been to give the learner a further test of the type used by Huckabay et al (1979). In this small study five different case studies were presented to the subjects followed by multiple choice questions to measure the extent to which learners could apply the theoretical knowledge to the case studies. The results showed that only the experimental group, those who received the N-CAL programme, transferred their knowledge significantly. However, the experimental group had been exposed to training similar to that used in the test instrument during the N-CAL programme whilst no such opportunity was afforded to the traditional group. In addition, the use of the N-CAL programme was as a supplement to the traditional method of lecture and reading.

Boettcher et al (1981) found that both an experimental group and a traditional group were able to apply their theoretical knowledge to case studies but there was no significant difference between the two groups. In this study N-CAL was used as a substitute for the traditional learning approach.

Benton (1988) reported a highly significant difference in the transfer of knowledge between an experimental group receiving instruction via an N-CAL programme and a traditional group receiving instruction via lecture / discussion. The N-CAL programme in this study was used as a substitute for the traditional lecture / discussion. It was suggested that this difference could be attributed to the interactive nature of the specific N-CAL programme under review which encouraged users to apply their knowledge in the N-CAL programme.

A number of studies have been identified which have attempted to measure the effectiveness of N-CAL on users' cognition. It is questionable, however, whether these studies reflect the effectiveness of N-CAL in general or indeed whether as Benton suggested in his study whether they merely reflect the effectiveness of the specific programme under evaluation.

Belfry and Winnnie (1988) in their review paper concluded that for N-CAL to be effective then the programme must be free from errors and the content must be consistent with educational objectives and the needs of learners. One method of ensuring this is to utilise formative evaluation and it is to this form of evaluation that the review now turns.

3.2.Formative Evaluation of CAL and N-CAL

The formative process of evaluation specifically related to CAL was described by Vasek and Volker (1984) as the evaluation during the construction of the CAL programme which would enable decisions to be made about the ongoing development of the learning programme. This is in contrast to summative or outcome evaluation which makes some statement about the end product of the development process.

It is useful at this point to return to the Nightingale Project (Norman et al 1988) for their initial aims were reported to be in relation to formative evaluation to ensure that :

i) the package represented valid educational aims and strategies in the nursing practice context,

ii) the content was accurate and up-to date,

iii) the package reflected reality whilst upholding the principles of good practice,

iv) appropriate evaluation tools were prepared for the summative evaluation,

v) the package was visually and operationally acceptable to users, and

vi) as far as possible, all technical problems had been remedied.

With the exception of the fourth statement the remaining statements do not specifically refer to formative evaluation for they could equally be utilised to make some statement about the end product of a N-CAL development process. Indeed the summative evaluation of the Nightingale Project reported the collection of data in relation to the programme's functionality (Norman et al 1988). Formative evaluation should give specific information, based upon statistical findings, to enable decisions to be made in relation to the ongoing development of the N-CAL programme. There was no detailed discussion of the actual methods or measures used during the formative evaluation stage of the Nightingale Project. It was, however, reported that design documents and learning modules were 'validated' with other nurse teachers, clinical experts, (one of whom was external to the institution) and some intended users. This validation resulted in a number of significant modifications being made to the N-CAL programme. The description of the validation of the learning modules from which, it is reported, significant modifications were made cannot be described as formative evaluation. The validation here represents no more than casual observation and, as such, changes appear to have been based on simple hunches rather than statistically significant results from formal evaluation exercises. In addition, fundamental difficulties were identified at the summative evaluation with the N-CAL programme which interfered with its use as an information tool. It is unfortunate that this was not more fully appreciated during the formative evaluation at the development stage and points to the need for efforts to be directed towards formative rather than summative evaluation.

Benton (1988) identified a strategy for the formative evaluation of an N-CAL programme in which the design and subject matter was examined iteratively using knowledgeable colleagues and independent experts. ***He concluded that if sound***

educational software were to be produced then extensive evaluation of the material at all stages of the development was required. Unfortunately there was no detailed discussion as to how to achieve this formative evaluation in any formal way other than a survey used by him to determine the content of N-CAL programmes as perceived by a needs assessment from qualified nurses. From the survey he identified areas which N-CAL should address, these included drug administration and the Nursing Process.

The NBS / SCET joint Project devised a "Process of Development " for the development of their N-CAL software. This included local and final field trials which could be equated to formative evaluation. During the local field trial, members of the working group, the programmer and the analyst (all those involved in the development of the N-CAL programme) observed groups of learners using the computer / N-CAL package in an attempt to discover difficulties which arose at the user interface. Notes were made by an observer whilst overseeing two or three groups of three to four learners using the learning package. On completion of the learning package the learners' attitudes and opinions were sought in respect of their perceived use of the programme. In the example given of a local field trial, it was concluded that the main objective was met with resulting discussion points. On the basis of the discussion points (a total of seventeen points were raised) modifications were to be made which, it was reported, would make the package easier for the learners to operate. An example of a discussion point follows "A few learners did not see information at the bottom of the screen until well into the tutorial, stumbled through it, not realising how and why things were happening" the response to this observation was "Not much can be done about this as you cannot ensure that the user reads the text". Eight of the seventeen points raised were dealt with in this way, six discussion points led to specific changes being made. The most worrying aspect of this type of evaluation is that there was no attempt to identify how many groups experienced the difficulties, or if there was any consistent difficulties across all or the majority of groups. Modifications to learning programmes driven by no more than an observer's impression of its use, possibly in an isolated incident, cannot be described as development driven by feedback from learners.
Finally, the N-CAL programmes from the SCET / NBS Project were distributed to

Colleges other than those involved with the development. Their opinions were sought which, it was reported, should contain tutor/ learner comments, overall comments, factual comments, suitability, presentation, and recommendations. It was recognised by SCET that the whole area of field trials and the feedback received was in need of review because much of the information was not informative to the development process (Brannan 1989). The timescale of this development process was also identified as being in need of review because learning packages took a considerable time to complete. During the five year period of this Joint Project only six learning packages were reported to be on final release in Colleges of Nursing in Scotland (Lindsay 1990). Once again the formative evaluation referred to here is not of any formal nature but merely a collection of casual observations and impressions from which conclusions were reached without any statistical analysis.

Whilst it has been claimed that formative evaluation is necessary there is nothing in the N-CAL literature in the UK which adequately describes this process. Claims where attention has been paid to the formative evaluation of an N-CAL programme only amount to development driven by hunches, casual observation and impressions rather than statistically significant results of feedback elicited from users.

Within the general education sector in the US Vasek and Volger (1985) outlined a formative evaluation process used by them in the development of a CAL programme to teach BASIC computer programming skills. Their formative evaluation process of the CAL programme consisted of three major stages

i) product planning

ii) product development and

iii) product evaluation.

The product ***planning*** consisted of needs assessment, instructional goal development, and criterion test development. They identified the need for their CAL programme from formal surveys. Alternatively, they suggest, requests from sponsors or a literature review may be used to identify the need for the CAL programme. The next stage was the development of instructional goals, represented as performance objectives, against which a measure of user performance could be made. The final stage of developing a criterion test provided the means by which user performance

could be measured against the instructional goals.
The product ***development*** consisted of specifying and developing the CAL programme. During the development the first Tryouts of the programme were completed by a limited number of users (five in total). The purpose of these Tryouts were to identify and remedy mainly technical errors.
The final stage of the Formative evaluation process which they outlined as product ***evaluation*** included individual Tryouts, Unit revision and Field testing. The individual Tryouts at this stage were again completed with a limited number of users (three at each Tryout session with three Tryout sessions completed, thus a total of nine users). They suggested that the developers of CAL programmes should observe users at the Tryout sessions to determine users' reactions to the programmes and users' ability to follow the instructions and complete the programme. Users' responses to specific questions and general comments were recorded. Notes were taken by the developers of mistakes or difficulties encountered whilst individuals were using the programme. Unit revisions of the CAL programme were completed after each Tryout session and the CAL programme was revised as necessary on the basis of the data recorded in response to specific questions and the observations made by the developers. The revised CAL programme was then re-tested with a small number of different users in a further Tyout session. It was reported that this cycle of Tryouts and Unit revisions facilitated users' chances of successfully completing the programme without experiencing difficulties or errors. The Field test was completed after the CAL programme had been adequately revised but before general release of the programme. In this study a total of fifteen subjects participated in the Field trial. On completion of the CAL programme the criterion performance test which had been developed earlier was administered to each user and, in addition, some computer captured data was also used as part of the criterion performance test. The scores users achieved on the criterion performance test were compared against standards which were set at the product development stage and minor adjustments to the programme were found to be necessary for the scores fell marginally below that which was felt to represent an acceptable level.

The formative evaluation process outlined by Vasek and Volger does attempt to utilise information from users to improve the quality of the learning programme. However, the methods of obtaining the observational data could be improved to include more objective data. In addition the number of subjects used from which data was extracted appears to be insufficient and may have led to the programme being revised based on unrepresentative incidents. Whilst even individual errors or difficulties experienced by users are undesirable, revisions should only be made as a result of statistically significant difficulties for, unless data is collected from a sufficient number of users to give statistical evidence of the occurrence of such errors, revisions of the programme might be based on little more than intuition.

So, whilst it has been demonstrated that the effectiveness of an N-CAL programme will be influenced by the quality of the learning programme (Day and Payne 1987, Brudenell 1990) there is no report of any formal method of ensuring objectively that the N-CAL programme is of quality.

4. Conclusions from Literature Review

The nursing profession's use of computers and information technology is set to proliferate in the 1990's. Nurse education must be ready to meet the future educational needs of the nursing profession. However, one of the greatest difficululties for educators, who more often than not have little knowledge of N-CAL and its associated technology, is in deciding how N-CAL should be used in a nursing curriculum. Not surprisingly, the approach taken thus far within Colleges of Nursing, where computing facilities have been utilised which are of no consequence socially or professionally to nursing and where independent and isolated topics of nurse education have been addressed through N-CAL programmes, has not led to an integrated use of N-CAL in a nursing curriculum.

The question needing an answer is - ***how should N-CAL be represented within a nursing curriculum to enable nurse education to meet the educational needs of the nursing profession?*** The problem lies in identifying the best way of constructing, evaluating and using N-CAL within nurse education.

Comparative evaluation techniques at first sight appear to give educationalists the most useful information, however, is it an appropriate question to ask? Is there a comparable teaching method? Are there not aspects of computer use which are unique? If it is to be believed that learning through the use of the computer offers unique situations (such as those offered by N-CAL programmes which utilise simulation and problem solving) then how can there be a comparable learning situation? The evaluation of N-CAL should concentrate on more fundamental issues such as assuring N-CAL packages of quality.

One of the aims of this research is to produce an N-CAL package which addresses the social, professional and educational value of using N-CAL. This will only be achieved if attention is paid to the hardware and software (the delivery system) and the information content of the N-CAL package assessed through formative evaluation. Chapters two and three will discuss further what is meant by the delivery system, formative evaluation and information content. The delivery system of more contemporary computing facilities and formative evaluation will be examined in Chapter two and the information content of the N-CAL package utilised in this project will be examined in Chapter three.

If greater attention is paid to the delivery system, the information content and formative evaluation this should help to ensure that an N-CAL package is meaningful and relevant to the nursing professions use of computers and, perhaps, lead to greater integration of these packages in a nursing curriculum in the future.

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Chapter 2

THE MISSING FEATURES OF N-CAL EVALUATION

Introduction

During the 1980s those working within N-CAL have focused on N-CAL for the achievement of educational objectives, declaring that N-CAL is about education not technology (Ellis 1974, Proctor 1988). Whilst this approach is seemingly a sound one, the net effect of this approach has been that major technological developments have been ignored and N-CAL has suffered as a result of this. Nurse education has pursued educational objectives utilising aging technology. As a result nurse education has not been in a position to take advantage of computing facilities which actually contribute to the ease with which computers are used and the ease with which they can be used to develop N-CAL packages of increasing complexity. Thus N-CAL has not been able to respond to the raised expectations of educationalists. ***N-CAL is primarily about the transfer of information, thus a strategy which has ignored the technology of the transfer vehicle has not been to the benefit of N-CAL or nurse education.*** If the real potential of N-CAL is to be seriously exploited, advantage must be taken of the wide range of multidisciplinary developments which have burgeoned during the last decade.
The following chapter will examine these wide ranging multidisciplinary developments. These are developments which particularly relate to the formative evaluation of N-CAL - an area which, it was identified, impacts the quality and the effectiveness of N-CAL. These developments will be reviewed within a framework of an analytical tool developed within healthcare by Donabedian (1968).

1. Formative Evaluation of N-CAL

It was identified in the previous chapter that the evaluation of N-CAL has predominantly focused upon outcome measures, with often conflicting and ambiguous results. Although formative evaluation was recognised as important there was little evidence of any formative evaluation strategy in use. Donabedian (1968), however, provides a useful framework for seeking solutions to the formative evaluation of

N-CAL. She recognised that the cause and effect link which is basic to any evaluation exercise is quite impossible to determine when the focus of evaluation is anything other than very simple (Jones and McCormac 1991a). Donabedian proposed a more realistic approach to evaluation through a division of the evaluation exercise into component parts and answers should be sought through the easier task of ensuring that the more manageable component parts are as good as they can be. It is proposed that the formative evaluation of N-CAL will be better served by utilising Donabedian's framework which requires evaluations of what she called the ***structures*** and ***processes*** which make up the system under review (in this case the learning programme). By responding appropriately to these evaluations, quality in the ***outcome*** of the learning programme development or of its use is more likely to be assured.
The following sections will look more closely at those structures and processes of N-CAL which should be considered during its formative evaluation.

2. Structures to be Evaluated within N-CAL

In Donabedian's framework, the Structures are the objects and components that comprise the system (as distinct from the Processes, which refer to the way the structures interact with each other and are used to perform a function). There are four structural components which should be considered in the evaluation of N-CAL and the following sections will examine those four structures: hardware, interface, software and user. In many of these components there has been considerable technological developments which N-CAL has largely neglected during the last decade. It is, therefore, necessary to identify some of the technological developments, consolidated in the 1980s and in common use throughout our society, which have failed to impact nurse education but which should be recruited for N-CAL in the 1990s if nurse education is to take better advantage of N-CAL. The technological developments relating to the structures identified are discussed below.

2.1. Hardware

Within N-CAL it is easy to see that there are many structures that relate to the hardware. There is now a wide variety of microcomputer hardware available at a comparable price to the Acorn BBC microcomputer but with vastly increased power, flexibility and sophistication. Programmers should no longer be restricted by memory, for now machines with 1M and 2M of RAM are common, as compared with a mere 64K or 128K of RAM available from earlier machines. Screen quality has also seen substantial improvements in the last decade, with a greater variety of letter fonts available and graphic and picture representation vastly improved.

The QWERTY keyboard is the most widely used method of inputting information to the computer, but it was originally designed in the 1860s by C. L. Scholes to slow down users by placing frequently used letter pairs far apart, increasing finger travel distance and thereby reducing the problem of key jamming (Shneiderman 1987 p. 229). The widespread implementation of the QWERTY keyboard makes it so well entrenched that even when other keyboards were designed such as the DVORAK layout in 1920 (which was demonstrated to reduce time and error, Kroemer 1972 cited Shneiderman 1987 p.231) few users were prepared to make the transition. During the 1980s, however, the basic computer input devices available to users have changed dramatically, with pointing devices now common alongside the QWERTY keyboard. Pointing devices can be grouped under two headings:

i) those that offer direct control on the screen surface such as light pens or touchscreens, and

ii) those that are controlled away from the screen surface such as the mouse, joystick or track ball.

Direct pointing devices appear attractive to the novice user for they offer direct control by pointing at the specific area of interest on the screen, however, there are disadvantages of this method of input. For example, pointing on an upright screen for any length of time is fatiguing for the upper arm of the user, another disadvantage is due to obstructing the screen display whilst pointing at the area of interest.

Indirect pointing devices eliminate the arm fatigue and hand obscuring problems, however they do require some training to coordinate the hand and eye to the area of interest on the screen. The mouse is an example of an indirect pointing device and is now virtually a standard feature of most contemporary computers. It has been demonstrated that individuals, using the mouse, are able to locate the cursor on the item of interest more quickly when compared with other indirect pointing devices such as the joystick or even when compared to keyboard entries such as the arrow keys (Card et al 1987). The mouse is available in a variety of forms but the basic concept is the same where the user's hand rests in a comfortable position on the desk, cursor

positioning is fast and precise and the buttons on the mouse are easily pressed. However, the QWERTY keyboard alongside the French AZERTY keyboard still remains the most effective device for some tasks. Indeed an experienced typist may find a pointing device slower than typing. Card et al (1987), for example, identified that over short distances the keyboard cursor keys were faster (the increased time comes from the problem of moving the hand off the keyboard to pick up the pointer). The mouse, however, is attractive to novices or the infrequent users for, unlike using a keyboard, with minimal training users are able to control the interface of the computer more easily and earlier through this device.
N-CAL has failed to take advantage of developments in memory, screen and mouse-based input and consequently, the software developments that have accompanied them.

2.2. Interface of the Computer

A less easily defined structure than the hardware component of the previous section is the Human-Computer-Interface. It is, however, no less important although within N-CAL evaluation it has been ignored. The interface is what the user sees or interacts with whilst using the computer and is often called the Human-Computer Interface (HCI). Gaines and Shaw (1984) recognised that the interface was historically the 'Achilles heel' of computer use, but today a considerable amount of effort has gone into improving the interface in the expectation of improving the communications between the user and machine. Indeed research has shown that redesign of the Human-Computer Interface can make substantial difference in learning time, performance speed, error rates, and user satisfaction (Shneiderman 1987, Jones and Buchanan 1989). There have been examples of successful and satisfying systems against which crude designs (like N-CAL's Acorn BBC) appear increasingly archaic. More than ten years ago the interface of the XEROX STAR computer, for example, was designed to be ***intuitive*** to users through the use of ***graphical rather than textual representations*** on the screen (Canfield-Smith et al 1987). The Apple Lisa was another example of an elegant new approach to interface design, but although it was not a commercial success, it provided the groundwork for the success of others. This type of interface is in contrast to the textual operating system such as MicroSoft Disc Operating System (MS DOS the IBM standard), and particularly the severely limited textual interface of the BBC microcomputer, where users must remember command sequences such as '*Delete Kath' to erase a file called Kath, or '*IW.' to initiate the loading of a wordprocessing package. If the user neglected to put the '*' at the beginning of the message it would not be accepted or understood, similarly if the user neglected to put the '.' at the end of '*IW' the wordprocessing package would not load.

A Graphical User Interface (GUI) utilises objects or icons on the screen which can be understood solely on the basis of their pictorial characteristics - for example, an icon of a wastepaper basket is used for the disposal of unwanted files or an icon of a typewriter may be used to indicate a wordprocessing package (Jones and McCormac 1991a). The user of a GUI drives the cursor with a pointing device which enables them to point and initiate actions from various objects or icons on the screen, whilst the results of their actions are visible to them on the screen (Jervell and Olsen 1985). Using the example above, to delete the file called Kath, the user of a GUI would point at the folder and drag that folder to the wastepaper bin. To initiate a wordprocessing package they would simply point at a picture of a typewriter and press a button on the pointing device to open it. ***Windows***, which are quite simply overlays of text or pictures, can be utilised by an interface design. Icons themselves can be thought of as small windows which when selected open out to display a large amount of information. Indeed, this design feature enables multiple sources of information to be available to the user without cluttering the screen - for example, help facilities or reminders of various functions can be selected without the need to remember specific commands or function key operations. Card et al (1987) provides an informative account of the numerous functions which can be utilised by windows. These features then have given rise to the ***WIMP technology***, (windows, icons, mouse, pull-down menus) utilising physical, spatial, and visual representations which appear to be easier to retain and manipulate than do textual or numeric representations (Shneiderman 1987 p 199). The Apple Macintosh was the first commercially available computer utilising a GUI or intuitive interface with the WIMP technology, drawing from the earlier experiences of the STAR and LISA. Today this approach is popular, IBM's most recent operating system OS2 and Presentation Manager utilises a GUI and WIMP technology as does the Acorn Archimedes RISK operating system. Indeed the package called "Windows" which runs under MS DOS utilises a GUI and WIMP technology and stands in marked contrast to the MS DOS interface. It is the interface of the computer which provides the link between the user, the hardware and the software and, thus, it is important that the interface should be easy to learn and easy to use.

The huge advantages conferred upon computer-use from the developments of this technology have been studiously ignored by N-CAL during its growth in the 1980s.

2.3. Software

Turning attention to N-CAL software as a structural component. Learning programmes were originally written by professional programmers using the language BASIC and educationalists advised on the nursing content (Norman et al 1988, Brannan 1990). More recently, however, nurse teachers have been able to take advantage of authoring languages to write their own learning packages (for example McCormac et al 1990, McCormac et al 1991). Authoring languages such as MICROTEXT and TOPCLASS are now found commonly throughout N-CAL (OSL 1990) but, although this represents a significant jump in software evolution, authors are still restricted in terms of what is seen on the screen and learners will experience little difference from the early BASIC programmes in what they see and do. For example, the user continues to interact at the interface by following textually based instructions and inputs information through the keyboard using designated keys or function keys. Thus the presentation of the interface remains very similar to that of a learning programme written in BASIC and the programme is driven in a similar manner to that of an N-CAL programme written in BASIC. The only difference is in the ease with which the author can build the learning package without the need for knowledge of low-level programming.

Users of more sophisticated hardware are more recently able to take advantage of high level authoring software and hypertext and it is these long standing structural innovations that have not been recruited within the field of N-CAL. HyperCard for the Apple Macintosh is a powerful yet easy to use tool. Its ease of use is due largely to the feature of object orientated programming allowing additions or changes to the learning packages to be incorporated easily and its power is evident in the high quality screen presentations (both textual and graphical) which non-programmers can produce. These features make it an ideal CAL development tool (Barden 1990). The programming language used within HyperCard is called HyperTalk, it uses English like commands and the programming of the package exists at various levels. For example, a few lines of HyperTalk can be directly associated with an object of interest possibly text or icons visible on the screen or in fact any screen sensitive area designated by the author (see appendix 1 for illustrations of this). HyperCard utilises Hypermedia which allows different media to be combined within the learning package and in its most rudimentary form Hypertext allows potentially huge amounts of information to be stored through the database facility of HyperCard and information to be accessed easily by the user (Baird 1988).

The terms 'HYPERMEDIA ' and 'HYPERTEXT' have been in use for some time, however, they are often used loosely and are the cause of some confusion. Conklin (1986) and Begoray (1990) have usefully described hypermedia as having the following characteristics:

i) information is presented in a network rather than in a conventional linear or hierarchical representation,

ii) a computer is needed to support the accessing of information, a process which is necessarily more complex when a network of information is used and

iii) the user of this information actively participates in the process of information access.

Hypermedia, then, gives new perspectives on the accessing of information within N-CAL for it offers the potential of providing an environment in which learners choose their own path through the information network - exploring related information at will and offering the opportunity of self-directed learning both in terms of pace and ***style*** (see appendix 1). Graphics are combined with the textual information to make attractive and interesting displays on the screen, this function can be used to present information in the form of detailed illustrations and pictures. These advantages are combined with a WIMP / GUI approach, similar to that described at the interface, available within the HyperCard packages or stacks themselves. Thus, N-CAL packages can be produced in HyperCard which are intuitive to users. For example, forward and backward pointing arrows can be used to progress or retrace through the learning package (appendix 1 illustrates this). Thus the advantages, described earlier at the interface of the computer, are also available within the authoring software and the learning packages themselves. Apple have been the forerunners in producing authoring software which utilises the WIMP / GUI technology in HyperCard and it has been distributed free of charge with Apple products since 1987. Others have followed, IBM Linkway and the Archimedes Genesis, both have a limited number of the more rudimentary features of HyperCard. In addition PLUS is a software application similar in power and flexibility to HyperCard now available for three different environments, IBM MSDOS based machines running 'Windows' or IBM OS2 or

Apple equipment. It is available at a cost of two hundred and eighty five pounds for each environment on which it is designed to run and packages written for one environment are theoretically transferable across the different environments. In practise some difficulties are experienced in transferring the packages but these can be overcome. Unfortunately its greatest drawback is the slow rate at which it runs and in an attempt to increase its speed to an acceptable level greater memory in RAM is required particularly when using the 'Windows' based application when a minimum of four megabytes is required. However, authoring software utilising the WIMP / GUI technology is becoming more prominant for different computing hardware, but presently the most advanced software for the price (now thirty five pounds for the developers pack) is still that offered by Apple Macintosh through HyperCard.

Users of the BBC are not in a position to take advantage of a WIMP / GUI environment or the high level authoring packages or Hypertext facilities. ***Increasingly, the sophistication, power, and flexibility not available to users of the traditional N-CAL technology stands in the way of the effective transfer of information.***

2.4. Users

Users are also a structural component of N-CAL. There are three significant users of an N-CAL package, the nurse learner, the nurse educationalist, and the programmer, but only the nurse learner has featured prominently in the majority of evaluation exercises. Clearly the nurse educationalist is a user with specific needs over and above those of the learner, relating to the use of N-CAL as a teaching resource to augment existing teaching practices. Therefore the educationalist's needs from a learning package must be considered in the formative evaluation of N-CAL. It has already been recognised in the previous section that the nurse educationalist and the programmer could be the same person and indeed (it could be argued) should be the same person, for it is the educationalist who knows what is needed from a learning resource such as N-CAL. Thus the ease with which educationalists can learn to programme in the chosen environment also becomes an important consideration in N-CAL evaluation. Although it has not been usual to think of the programmer as a user their contribution identifies them as a significant user not only during the development of the learning package but also after its completion. It is the programmer who is required to input the relevant information into the computer and produce high quality presentations of complex learning packages during the development. However, unless learning packages are seen as static with a limited shelf life, then the ability to easily change and update learning packages to keep pace with changes in practice and the ability to modify them to suit local needs also becomes an essential function of the programmer. The ease with which the programmer can implement the initial design, input information, as well as incorporate alterations over an extended period of time becomes an important aspect which should be considered in the formative evaluation of N-CAL structures.

Having examined those developments in relation to the quite different structural components that comprise the N-CAL scenario it is now necessary to examine the processes through which the structural components interact at use.

3. Processes to be Evaluated within N-CAL

Through structures different aspects of computing were identified and different users were also identified. It was also recognised that users or humans communicate or interact with the computer at the interface. The interaction which takes place at the interface is know as the Human-Computer Interaction, (also HCI). This has become an established area of study which collaborates methods from computer science, cognitive psychology, ergonomics and communications, witnessed by the large and growing literature on the subject. Human-Computer Interaction has become a well developed area of knowledge relating to humans using computers. This approach concentrates upon the interaction which occurs at the computer to enable the effective transfer of information by improving the ***usability*** of the computer interface. The concept of usability of computer interfaces has been recognised as a legitimate area of study for many years (see Walther and O'Neil 1974).

It is interface evaluation which should have been at the centre of N-CAL evaluation. Regretfully, it has not been. The following section is intended to illustrate, rather than exhaustively review, aspects of HCI which are likely to be of value when considering the evaluation of N-CAL.

3.1. Styles of Interaction

There are different styles of interaction (reviewed by Shneiderman 1987) including command language, menu selection, and direct manipulation.

Command languages require the user to learn and remember the syntax and semantics of the computers commands and functionality, once learned they need to be used frequently to be retained in memory. Users require considerable training and need to be knowledgeable about the task domain and computer concepts for they initiate actions through the command sequences rather than responding to the interface of the computer. Command languages are difficult for beginners to learn for their attention is forced away from the actual task with the need to learn and type into the computer a string of commands which are unfamiliar and are likely to have little or no meaning to them. Command languages are traditionally the method of interacting with the computer and they offer a rich functionality to the experienced and knowledgeable user. As such, they are most suitable for the experienced user who is willing to master their complexity to benefit from their wide ranging functions. Some require years to master. MS DOS and UNIX are examples of command languages.

Menu selection is attractive to the novice or infrequent user for a list of permissible actions or choices are displayed from which the user can select. This style of interface negates the need to learn complex command sequences for it relies on recognition rather than recall. The Apple Macintosh utilises pull-down menus which appear on the screen when activated by the mouse. Menus can also be embedded in text or graphics allowing menu items to be placed within a context. For example, a map of Europe might allow an exploration of any of the countries of Europe or a paragraph of text containing unfamiliar words will provide an explanation of any of those words. Contextual embedding of menus will keep the user focussed on the task whilst allowing exploration of an item of interest.
Although menu selection is an appealing form of interaction to the novice or infrequent users, experienced users might become frustrated when they are required to make several menu selections to complete a familiar task (Hiltz and Turoff 1981 cited Shneiderman 1987 p. 108). This can be overcome by providing the experienced user with short cuts such as keyboard equivalent functions.

The most advantageous style of interaction to novice, intermittent and frequent users is **direct manipulation** (Shneiderman 1987). This style of interaction replaces the keyboard entry or menu choices with cursor motion devices to select from a visible set of objects. Several authors have attempted to describe the basic principles of this interactive style. Hatfield (1981) described the approach as "What you see is what you get (WYSIWYG)". Nelson (1980) described a principle of virtuality where the design of the conceptual structure and feel of the system is more important than the reality (which by contrast is unimportant to the user). Virtuality is a representation of reality that can be manipulated by the user. Shneiderman (1987) gives an analogous example of direct manipulation using a driver of a car turning left -

"the scene is directly visible to the driver through the front window. To turn left, the driver simply rotates the steering wheel to the left. The response is immediate and the scene changes, providing feedback to refine the turn. Imagine trying to turn by issuing a command LEFT 30 DEGREES and then having to issue another command to see the new scene; ..."

Hutchins et al (1986) describe the concept of direct manipulation as being involved directly through objects rather than communicating with an intermediary. Indeed the traditional role of an interface required the user to describe the actions of interest and the system described the results of those actions. Instead, using direct manipulation, the user performs those actions and the system presents the actions taken upon the objects with visual feedback.

Using direct manipulation principles does not, however, ensure success in itself. Its acceptance can be undermined by poor interface design (Shneiderman 1987). Indeed choosing the right objects for a given action is not an easy task, for graphic representation might be misleading. An icon might convey its meaning to the designer but users must learn its meaning through systematic exposure to it and its functions. The user might become more confused if the objects convey the wrong information or lead to incorrect conclusions being reached on the basis of its analogical representation. Graphic representations can require excessive screen display space or lead to a cluttered representation which is more confusing (Booth 1989).

For N-CAL to take advantage of the developments in interface design then it is essential to identify a methodology for the systematic testing of the interface. The way users interact with the interface needs to be evaluated and performance measures will consequently be examined for this purpose. First, however, it will be valuable to consider the area of HCI from which such performance measures can be derived -

Cognitive Psychology.

3.2. Human-Computer Interaction and Cognitive Psychology

Human-Computer Interaction from a cognitive standpoint examines the user's behaviour at the interface in relation to the cognitive model that the user has of the task and the system. Much of the research has focussed on how users process information about a task and system, apparent in statements such as that by (Kidd 1982 cited Booth 1989) :

" If interactive computer systems are to be easy and efficient to communicate with then their dialogue design must be compatible with the information processing characteristics of the human mind".

Many researchers have attempted to identify what users do at the interface.

Gulfs of Execution and Evaluation

Norman (1986) described the difficulties which occur at the interface as ***gulfs*** encountered in attempting to relate the users psychological goals to the physical variables and controls of the task at the interface. The ***gulf of execution*** occurs when the user knows their goal, they know what is to be achieved, but they do not know how to achieve that goal, they do not know what physical variable to adjust or in what way to adjust the physical variable to achieve their goal. The ***gulf of evaluation*** occurs when the system has changed but the user is unable to work out or understand what has changed in the system or even whether the change is consistent with their original intention or goal. The gulfs can be bridged either by the designer bringing the system side closer to the user by matching more closely the needs of the user or by the user moving their description of their goals and intentions closer to the description required by the system. Norman (1986) identified 7 stages of user activity in the process of performing and evaluating a task

1. Establishing the Goal
2. Forming the Intention
3. Specifying the Action Sequence
4. Executing the Action
5. Perceiving the System State
6. Interpreting the State
7. Evaluating the system state with respect to the Goals and Intentions

The practical implications of the existence of these gulfs points out a critical requirement of the design of the interface. If the system is to match the needs of the user the interface must be readily interpreted and manipulated. The interface design can now be examined in terms of the different stages of user activity. For example, command language and menu selection approaches are distinguished by the demands they place on the user. Menu selection provides the user with a clear indication of permissible actions thereby assisting the user in the activities of intention formation and action specification, but menu selection frequently makes execution more difficult, annoyance can build if users must wait for lengthy menus, and extra information can distract the user from their original intention. In contrast command language supports the stage of execution, for task completion is usually faster, but inhibits the stages of intention formation and action specification for users are required to memorise the options available to them and formulate complicated requests to specify the action (Schneiderman 1987).

Norman (1986) supported an interface which utilises visual presence, such as that offered by direct manipulation, as an aid to the various stages of user activity. Visual presence helps the user in the generation of intentions by reminding the users of what is possible, action selection is aided by visual presence because the visible items can be translated directly into possible actions. Visible items also help the user in the execution of their actions particularly where it is possible to point at the item to initiate the execution. Interpretation and evaluation is also aided by providing the user with visual feedback of what has been done.

Norman has provided a useful account of how people interact with computers, but in reality the activities are difficult to separate from one another and, as such, it is not intended to offer specific guidelines to the details of the design of interfaces but offer general guidelines to the design process of the interface.

Syntactic / Semantic Model of User Behaviour

Another useful way of considering what users do at the interface has been described by Shneiderman. This model was first developed by Shneiderman and Mayer (1979) in the context of programming-language experimentation. Basically two kinds of knowledge were reported in long term memory:

i) Syntactic knowledge - the details of command syntax, and

ii) Semantic knowledge - the concepts of functionality.

Syntactic knowledge is system dependent, (although there may be some overlap among systems) it includes knowledge of permissible keystrokes or sequences of commands. The knowledge is arbitrary and is acquired through rote learning. Thus, the knowledge is easily forgotten unless frequently used. ***Semantic knowledge is system independent***, it is hierarchically structured with domains of knowledge containing high level concepts down to lower level functions. For example, in the domain of text editing, a recognised concept across all word processing packages is the movement of text. A specific function might be moving a word or a line of text or a paragraph or maybe even a whole document. Low level semantic knowledge is anchored to concepts in familiar domains of knowledge and as such is quickly learned and is likely to be retained in memory. The processing through the syntactic / semantic model suggests the user identifies the task at the higher level domain and breaks down that task into the lower level functions and finally transfers the function into the specific command syntax. Generally the semantics from the higher level concepts to lower level functions are the same across different systems but the actual syntax is likely to vary. User interaction will be enhanced, according to the syntactic / semantic model, when the problem domain is visible to the user and actions are immediately visible and comprehensible within the domain of knowledge. The closeness of the problem domain to the command syntax reduces the problem solving load by the user (Shneiderman 1982). Interface designs which utilise direct manipulation attempts to reduce the user effort by representing and displaying the concepts and functions directly to the user without the need to learn complicated syntax. In support of this Te'eni D. (1990) compared the effect of feedback presented as information with feedback generated by direct manipulation and demonstrated that users receiving the feedback from direct manipulation made less errors and took less time than those users who were given dialogue feedback. Observations such as this should be having a direct impact upon N-CAL design and use. There is little evidence of this, however.

Modelling Techniques

Modelling techniques are forms of task analysis (Booth 1989). User modelling is most commonly represented as formal grammars, where the interface is described using conventional grammar or symbols and the number of rules within the description of the users tasks at the interface is assumed to reflect the cognitive complexity of the task being performed by the user at the interface.

The argument presented by Booth (1989) was that these models are more of a research tool for they are often complex and difficult to use, therefore, they are not suitable as a practical tool which designers could utilise. Whilst the methods of collecting and analysing user behaviour for cognitive modelling are useful, the application of a modelling technique is not possible within the constraints of the present study, as such only a brief look at a few of the more well known models will follow and the methods used to analyse user behaviour will be discussed in the section HCI and user performance measures.

Moran (1981) has suggested Command Language Grammar (CLG) as a means of understanding the Human-Computer Interaction, his description of CLG complements both Norman's theory of user activity and Shneiderman's semantic / syntactic model. CLG is a representational framework for describing aspects of the user interface of interactive computing. The structure of CLG identifies 3 major components to user interaction with 6 levels: i) Conceptual component, defined by 2 levels the Task level and the Semantic level, ii) Communication component, described by the Syntactic level and the Interaction level, and iii) Physical component, comprising of the Spatial layout level and the Device level. Moran describes the first 4 levels as :

Task level - The user comes to the system with a set of tasks that he wants to accomplish. The purpose of the Task level is to analyse the user's needs and to structure his task domain in a way that is amenable to an interactive system. The output of this level is a structure of specific tasks that the user will set for himself with the aid of the system.

Semantic level - A system is built around a set objects and manipulations of those objects. To the system these are data structures and procedures; to the user they are conceptual entities and conceptual operations on these entities. The Semantic level lays out these entities and operations. They are intended to be useful for accomplishing the user's tasks, since they represent the sytem's functional capability. Thus, the Semantic level also specifies methods for accomplishing the tasks in terms of these conceptual entities and operations.

Syntactic level - The conceptual model of the system is embedded in a language structure, the command language, for users to communicate to the system. All command languages are built out of a few syntactic elements: commands, arguments, contexts, and state variables. The Syntactic level lays out these elements. The "meaning" of each command of the system is defined in terms of operations at the Semantic level, and the methods at the Semantic level are recorded in terms of

Syntactic level commands.

Interaction level - The dialog conventions for the user-system interaction must ultimately be resolved as a sequence of physical actions - key presses and other primitive device manipulations by the user and display actions by the system. The Interaction level specifies the physical actions associated with each of the Syntactic level elements, as well as the rules governing the dialog.

The purpose of the level structure of CLG is to seperate the conceptual model of a system from its command language and to show the relationship between them (Moran 1981). CLG was the first model which attempted to break down the interaction into task, semantic, syntactic and interaction levels. This division of the Human-Computer Interaction has been used widely within HCI.

The GOMS (Goals, Operators, Methods, and Selection rules) developed by Card et al (1980) is probably the best known model. The purpose of this model was to predict human behavior at the interface. It can be used to predict routes through tasks and task times. However, it does not take into account novices or intermediate users and it assumes performance which is error free.

TAG (Task-Action Grammar) developed by Payne and Green (1986) is a model of how the user relates their conceptual model of a system onto their actions at a system. The model accounts for how user intentions are converted into action specifications and the action specifications are simply a list of actions to perform or simple tasks which are the building blocks of a task. These simple tasks are selected and ordered for any intention or goal. "The central aim of TAG is to formalise (the mapping from the task level to the action level) in such a way that simple metrics over the grammar, such as number of rules, will predict aspects of the psychological complexity of the mapping" (Payne and Green 1986).

TAKD (Task Analysis for Knowledge Descriptions) developed by Johnson et al (1984) like TAG focuses on the performance of the user for its purpose is to identify the human knowledge requirements necessary for successful completion of a task, but information is sought not only in relation to the specific actions but also in relation to specific objects and how these relate to each other.

A common criticism of grammars such as those listed above is the lack of strict criteria for choosing the level of specification. As a result the number of rules generated is not only dependent upon the true complexity of the task but also on the level at which the tasks are specified or broken down. It is often practically difficult to distinguish a division of activities.

User Model and Metaphors

The term User Model is most commonly referred to as a model of the user's knowledge of the task and the system, but it may also refer to a representation of the user embedded within the system or it could refer to the designers model of the user (Booth 1989). The difficulty for the designer is ensuring that users acquire an appropriate mental model of the task or the system. One of the ways in which this can be achieved is by presenting a metaphor of the task or the system to the user (Booth 1989). Metaphors play an important role when new knowledge is being acquired. New knowledge is learned by building on existing knowledge, thus if unfamiliar concepts are presented in such a way as to associated them with existing concepts learning will be easier. One of the most popular metaphors used in interface design is that of the desktop metaphor successfully exploited by Apple but increasingly utilised by many other companies including DEC, IBM, Hewlett Packard, and even Acorn. HyperCard (discussed earlier) is a software application which utilises metaphors within the application itself to aid the development, for example, of a HyperCard learning package. However, poorly chosen metaphors may confuse the user or even restrict the potential use of the programme. ***The question is how can metaphors be used effectively within N-CAL?*** Attention will now focus on the concept of usability within HCI in an attempt to answer the question and begin to provide a systematic method of evaluation that could be used in N-CAL.

3.3.Usability

The main feature of the Human-Computer Interaction approach is through the highly developed concept of usability. Usability is presented as a concept which can limit the degree to which a user can realise the potential utility of a computer system (Eason 1984). For N-CAL this refers to the extent to which users can utilise the package to transfer information. Continuing along the view of multi users, this refers not only to the ***transfer of information from the computer***, by nurse learner or nurse tutor, but also to the ***transfer of information into the computer*** by the programmer or the tutor. Usability specifically relates to the processes, in Donabedian's framework, through which the structural components interact.

A coarse grain measure of usability has been viewed as the extent to which the system or N-CAL package is used (Eason 1984). Unfortunately, although this might give an indication of the poor quality of N-CAL packages available, (for few are used within nurse education to any great extent) it is not fine grain enough to be a useful measure. Shackel (1986) has suggested that a more appropriate measure comes from the tool related activities which cause the system or learning package to be used. This would give more useful measures for the production of N-CAL packages.

It is suggested that N-CAL has much to gain from the field of Human-Computer Interaction for the HCI approach to evaluation provides a useful tool during the development which relates directly to the formative evaluation neglected by N-CAL. The emphasis of the HCI approach to evaluation is more in terms of a device to help develop products rather than as a device to simply test products. Indeed, usability testing within HCI is considered to be an essential part of a systems evolution and it has been the usability approach to evaluation that has concentrated on practically improving systems in the commercial environment (Booth 1989). As a testimony to this IBM have recently announced the opening of their Usability Center in London to potential customers to ensure the most effective use of systems (IBM Multiples Consultancy 1991).

The usability perspective provides practical feedback at different stages of the design and development process. It includes testing of prototypes with different users to provide objective information as to how the system could be improved. Thus, the system evolves from a development-evaluation cycle known within HCI as iterative prototyping (Booth 1989).

Usability testing throughout the development of an N-CAL package could provide an objective framework for the formative evaluation of N-CAL. The next section will look at the actual measures used to provide this objective framework.

3.4. Evaluation of the Human-Computer Interaction (Performance Measures)

Measures such as user performance, and protocol analysis (a technique developed within cognitive psychology) provides the most useful data indicating how a system is used (Monk 1986). User performance measures include time, error and patterns of use, whereas protocol analysis include visual and verbal protocols from which cognitive complexity measures can be identified. Booth (1989) also includes measures of goal achievement and user attitudes in the range of measures which represent usability. Each of these measures will be reviewed in more detail in the sections below.

3.4.1.Time, Errors and Patterns of Use

Measures of time, errors and patterns of use are user performance measures which can be obtained from computer captured data. For example, a trace facility can be included in the background of a learning package without any additional overheads. The trace can be used to give an accurate and precise recording of the users path through the learning package with exact times spent on each particular screenful of information. Measure of time may be used as a gross indication of difficulties experienced by users, for if one user takes twice as long as another user then it is likely that some difficulties were experienced by the user taking longer. Errors, on the other hand, are likely to give more precise information and have the potential to reveal where the difficulties have occurred. Errors may be used to identify incorrect or innapropriate patterns of use. In addition a correlation of the time and errors is likely to identify if errors caused time delays or, more importantly, if errors were caused by users spending too little time using the package.

There is likely to be a degree of ambiguity, however, if error information is obtained only from a trace facility, for whilst the trace will give an accurate account of what the user does it will not give any indication as to why the user followed the path that they did. What may be interpreted from the trace as an error may have been an intentional exploration in a manner not recognised as such if a trace is the only facility used to determine errors. It is, therefore, essential to utilise other methods of collecting error information to disambiguate what the trace indicates and the collection of visual and verbal protocols are likely to provide the details of the user performance not recognised from a trace facility.

3.4.2. Visual and Verbal Protocols

Whilst visual and verbal protocols and even eye movement protocols are concurrent measures of user performance which require considerable time and effort to both collect and analyse, they do provide a more detailed and informative account of why the user acted in the manner that they did. Protocols such as these produce a record of what the user says and does and even what they are specifically looking at, whilst using the learning package. Concurrent protocols can reveal in remarkable detail what information the user was attending to while performing the task at the computer, and by revealing this information protocols can provide a picture of the way in which the task was performed.

Protocols can be obtained in a number of ways:

i) observers recording user's visible behaviour,

ii) tape recordings of users verbalising their thoughts and even

iii) video recordings of all the user's behavioural responses including eye movement.

The information obtained can be used in conjunction with a trace facility to identify more accurately errors and difficulties experienced by users.

Ericsson and Simon (1984) provide a comprehensive review of the literature on verbal protocols. One of the difficulties with using data obtained from protocols is in the objective analyses of vast quantities of data. However, they do have the potential of providing detailed data of the process of interaction.

3.4.3.Affective Measures and Goal Achievement

User attitudes and goal achievement are more usually associated with a measure of outcome for they represent measures which are formed as a result of using an N-CAL package. However, they also have a place in the formative evaluation strategy, for the development of an N-CAL package involves interim solutions or protoypes which need to be evaluated and the development / evaluation cycle from which an N-CAL package evolves intrinsically involves the discovery of new goals. Thus, user opinions and attitudes of the interim solutions and the achievement of goals is also an ongoing meaure which contributes to the formative evaluation of an N-CAL package. User attitudes are easily collected retrospectively from established questionnaires, structured or semi-structured interviews. However, interpreting attitudes is never easy, for users respond in a variety of ways for a variety of reasons. It is important therefore to ensure the validity of the questionnaires so that what is measured is what is intended to be measured. Care should be taken not to place to much significance on this measure for it is clear that what is liked most is not always what is best. For example the QWERTY keyboard has become established not because it is the best method of input but because users prefer it. Within education learners would be more likely to prefer the friendly lecturer who told them jokes rather than the lecturer who presented the information in a factual and logical manner but without humor. Which lecturer is best is not always recognised by the learner. Similarly users attitudes about an N-CAL programme will not always represent what is educationally best. It is, therefore, important to consider affective measures alongside measures of goal achievement which either relate to the goals of using the package or to the achievement of educational objectives. In either instance the achievement of goals can only be measured against the goals of a specific N-CAL package. To determine whether the goals have been achieved measures could be taken from the trace and protocols to identify the extent to which tasks have been completed or achieved within the package. The achievement of educational goals can be determined from tests either set within the package itself or from tests set external to the package.

Whilst some of these measures have been utilised in the evaluation of N-CAL ***it is the range of measures which represent usability, no measure can be taken on its own and used with any degree of validity or reliability***. The use of isolated measures have been shown to be highly ambiguous producing often conflicting results (see Brudenel 1990 for an example of this).

Evaluation measures applied to the three significant users of N-CAL

Usability measures apply across the three significant users of N-CAL identified earlier, learner, educationalist and programmer. It is easy to identify the measures as they apply to learner users but probably less easy to identify the value of these measures when educationalists or the programmer is the subject of the evaluation. However, the nurse educationalist is instrumental in refining the information content of the learning package by making an informed judgement of the extent to which the educational objectives are reached. The educationalist understands the nursing content and the knowledge level of the learner and is, therefore, the best person to assess the relevance and accuracy of the nursing content as an educational tool. The educationalist can also be used to assess the effectiveness of the delivery system for time and error data from the educationalist represents how easily the package can be run rather than how easily the information content can be understood or assimilated. This identifies an important distinction between using the package and transferring information from the package. When the programmer is the subject of usability evaluation programming time and programming errors could be examined to identify differences between authoring tools or programming languages as well as the less objective measures of attitudes towards

the different methods of developing the learning package. In addition the programmer is always striving to meet identified goals and objectives of the N-CAL package, but protocol analysis is not likely to be of any great value when the programmer is the subject of the evaluations.
As well as the three different users of N-CAL, different types of users could be used to evaluate the learning package at different stages of the development. These include computer naive users, computer experienced users, content specialists, users with limited content knowledge, maybe even hostile and friendly users.

A wide range of developments have been reviewed relating to the ***process components*** of N-CAL and various performance measures have been identified which could be utilised to more objectively evaluate the usability of N-CAL packages during the formative evaluation.

4. Conclusions

It is a truism that the computer revolution will not be judged by the complexity or power of the technology but more by the service to human needs (Shneiderman 1987). However, it is suggested that users of a GUI / WIMP / HYPERTEXT environments are provided with a service which is easy to learn, easy to use and is likely to lead to the more effective transfer of information into the computer and transfer of information out of the computer.
The current project is designed to explore the use of more contemporary computing facilities through the well established advantages identified in using the Apple Macintosh computer and HyperCard to develop a learning package for nurse education and with particular attention given to formatively evaluating the package.
Choosing the most appropriate hardware / software combination will always be a compromise between the ideal and the practical, determined largely by availability and cost. Whilst it is recognised that there are disadvantages with this choice, the most prominent of which is a monochrome presentation, it does represent some of the more significant advantages of contemporary computing but at a comparable price to the Acorn BBC and so affordable to nurse education. The greatest advantage in using the Apple Macintosh and HyperCard is from its established use. A wide range of graphics and HyperCard packages or stacks are available through public and shared software

and these can be imported into a learning package. There is also a great deal of expertise available through help groups such as the Scottish HyperCard Users Group (SHUG) which offer support from experienced users and a library of freely available software.

Intensive evaluation using a range of usability measures will be utilised from the established, interdisciplinary area of Human-Computer Interaction. Performance measures of user behaviour will provide objective data of the interaction between the four structural components, hardware, software, interface and user. Since the evaluation process has been identified as being integral to the development process, it is intended to utilise usability measures to evaluate the learning package iteratively with feedback contributing to further prototypes and additional measures of user attitude and goal achievement will be used to assess the result of these prototypes.

An N-CAL package, developed iteratively in small discrete stages, will be used as a ***vehicle*** for the exploration of ***comprehensive evaluation measures*** which could be used to more appropriately evaluate N-CAL packages during their ***development***. Chapter three will identify in more detail the nature and the content of the N-CAL package and the contrast with the traditional N-CAL approach in the UK will be made explicit.

Using Donabedians framework, ***the structure and process components of N-CAL evaluation are the focus of this thesis*** in the belief that quality in the outcome will be better assured.

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Chapter 3

DESCRIPTION OF THE STYLE AND CONTENT OF THE N-CAL PACKAGE UNDER DEVELOPMENT

Introduction

Attention was focussed, during the development of the N-CAL package, on both the ***delivery system*** and the ***nursing content***. A clear distinction is made between the information contained within the learning package (that is the nursing content) and information of the delivery system required by the user to gain access to the nursing content (computer-use skills or knowing how to use the package). The delivery system of this N-CAL package is designed to make using the computer as easy as possible. Thus, limitations in using the computer do not stand in the way of acquiring the nursing information. Computer-use within nurse education remains limited despite attempts by National Projects to encourage its use. The approach thus far, however, has ignored the delivery system of the computer and concentrated upon the user attempting to increase the extent to which nurses are exposed to computer-use and in doing so attempting to change nurses attitudes towards computer-use.

This project concentrates upon the computer itself and attempts to improve the usability of the delivery system by utilising WIMP / GUI / HYPERTEXT. This project also aimed to use nursing information within the N-CAL package which is central to nursing. The Nursing Process was chosen for it represents nursing information which is relevant throughout a nursing curriculum and information which is also relevant to nursing practice. It is anticipated that an N-CAL package such as this may be utilised as an integral and regular part of any nursing curriculum.

The N-CAL package delivery system and the nursing information will be described in some detail.

1. Nursing Computer Assisted Learning Package

The package consists of two sections - the Tutorial section which is designed to teach the use of the delivery system and the Nursing section which uses this delivery system to present the nursing information. Users are introduced to the computer-use skills of the delivery system and they are able to practise these skills within the Tutorial section before advancing to the Nursing section where they are required to utilise the computer-use skills to access the nursing information. A selective number of screens from the Tutorial section and the Nursing section are illustrated in Appendix 3.

1.1. Tutorial Section (Computer-Use)

This section is divided into three modules (Introductory, Intermediate and Advanced Tutorial modules). This section does not contain any nursing information for it is designed to teach the range of Apple Macintosh computer use skills that will be needed by the learner to successfully use the Nursing section . The Tutorial section assumes that the user is naive to both general computer use and Apple Macintosh use in particular. There is an option to jump in at any of the Tutorial modules or, alternatively, (for those users who have experience of this type of interface or have used the package on previous occasions) to move straight into the Nursing section (see Appendix 3).
The Tutorial section consist of a total of sixty interactive screenfuls of information and takes approximately thirty minutes to complete giving the user sufficient practise to enable them to go on and complete the Nursing section with ease. ***The aim of the Tutorial section is to introduce, consolidate, and rehearse the computer-use skills of the delivery system.***

Goals of Tutorial Section.
The Tutorial section is designed to enable users to achieve ***two major goals*** which represent the major characteristics of the WIMP / GUI / HYPERTEXT technology. The goals are behavioural statements describing in general terms what users should be able to accomplish whilst using the Tutorial section.

On completion of the Tutorial modules it is expected that the user will be able to :

1. Utilise information presented on the screen in three different forms:
   textual (conventional N-CAL equivalent to a computerised book, but in this package it also represents the facility to explore the meaning of text through the HYPERTEXT facility)

iconic (pictorial representations or symbols convey information, for example, a forward pointing arrow)

graphics (where detailed pictures or drawings convey information).

2. Use the Mouse / Button system rather than the QWERTY keyboard to interact with the package.

The Tutorial modules acquaints users with the range of representations (text, icons and pictures) which are subsequently used in the Nursing section for conveying information. In addition the Tutorial section introduces the Mouse / Button system and gives the user fairly extensive experience of using this system. Whilst most nurse learners will have used a keyboard at some time few will have used a Mouse / Button system. It is, therefore, essential that training is sufficient to enable them to use the facilities to gain access to the nursing information in the Nursing section to follow.

Objectives of the Tutorial Section

Specific educational objectives have been formed in accordance with the generally accepted format of learning objectives (Bloom 1956, Mager 1962). These objectives are behaviourly stated and provide a measure of user performance or outcome.
The objectives provide the detail of how the goals (identified above) are to be achieved.

On completion of the Tutorial section the user will have:

1. Identified transparent screen buttons which can overlay textual, iconic and graphic information.
(Buttons can be used by the user to initiate computer actions associated with the information which the buttons overlay. For example, the computer action of moving to the next screenful of information could be represented by a button overlaying i) text 'GO NEXT' ii) an icon of a forward pointing arrow or iii) a picture of book with the pages turning).
Users need to be instructed that buttons can overlay any form of information and the way in which users interact with these buttons is outlined in the following objectives of the Tutorial section.

2. Demonstrated moving the cursor over screen buttons. (Users move the pointer around the screen by moving the mouse on the desk top).
The Tutorial section teaches users to move the pointer over the information which they intend to respond to and respond in the way detailed in the next objective.

3. Initiated computer actions associated with screen buttons. (The user initiates the action by manually clicking the mechanical button on top of the mouse after having moved the screen pointer over the button. For example, initiating the computer action of the button overlaying the icon of a forward pointing arrow is dictated by the programming underlying that button. In this example the action performed would be to move to the next screen.
The Tutorial section teaches users how to initiate the computer action associated with any single button and an indication of the action is provided by the information that the text, icon or graphic that the button overlays.

4. Identified that the range of screen buttons can have one of two different functions: interact with the current screen or move to a different screen.
Detailed information is gained by paying attention to the information which is presented on the screen and interacting with the current screen. New areas of information are presented when the user moves on to new screens.

Users progress through the first quarter of the Introductory module of the Tutorial section with a single keyboard press, thereafter they are weaned from the keyboard to the Mouse / Button system. The remaining modules are completed using only the Mouse / Button system. Users are required to respond in a variety of ways and are able to practise their newly acquired computer-use skills as they progress through the Tutorial section.

1.2. Nursing Section (Nursing Information).

The Nursing section presents the basic concepts and structures underpinning the Process of Nursing. The four stages of the Nursing Process (Assessing, Planning, Implementing, and Evaluating) are ***described***. Specimens of documentation (such as those used in the Assessment and Planning stages) are completed with simple examples of patient problems ***demonstrating*** how this Process can be used to complete a Nursing Care Plan (appendix 3). Pictures are used to illustrate aspects of care during the Implementation stage. Finally, the Evaluation stage is represented by alterations made to the Nursing Care Plan. This section has in excess of ninety screenfuls of information and takes approximately eighty minutes for new users to complete.

Nursing Background

The Process of Nursing was chosen as a topic because within nursing it is ubiquitous - it is a basic principle of nursing taught from a very early stage and applied throughout nurse education and clinical experience. The Nursing Process is used to teach the structure of nursing within education and it is used in nursing practice to nurse patients. In addition, ***it is through the use of the Nursing Process that computerised Nursing Information Systems enable nurses to use the computer in clinical practice to build Patient Care Plans.*** Thus, the N-CAL package addresses both the educational and professional value of using computers in nurse education.

The nursing content of the Introductory module of the Nursing section was largely determined through a reveiw of appropriate literature dating back to the initial development of the Nursing Process in the USA during the 1950s and through to its widespread implementation and acceptance in the UK today. The 1967 National Commission for the Study of Nursing and Education in America considered it important for nurses to pursue nursing activities in a systematic way. Deliberate goal-directed activity was to be focussed upon in nursing and this would enable the evaluation of goal achievement (Yura and Walsh 1978). The Nursing Process was first introduced into a curriculum of nurse education in the UK in 1973 by the University of Manchester Nursing Studies Department (Mcfarlane and Casteldine 1982). It received rapid acceptance due largely to statements from National and International bodies including the General Nursing Council in 1977 (now the United Kingdom Central Council) which recommended that "the concept of the Nursing Process provides a unifying thread for the study of patient care and a helpful framework for nursing practice"(Hayward 1986). Following this, the Scottish Home and Health Department in 1979 formed a liaison officers' group, on which all fifteen Scottish Health Boards were represented, to coordinate the introduction of the Nursing Process into nursing practice in Scotland. On a wider scale, the World Health Organisation in 1985 recognised the Nursing Process as a priority study area (Farmer

1983). The Introductory module of the Nursing section contains a range of background references which are drawn to the attention of users at appropriate parts of the module.

The Nursing Process is clearly the very foundation of nursing practice for it is a method through which the Philosophy of nursing is expressed and the Art and Science of nursing is implemented. The Philosophy of nursing has been described as an expression of values relating to, on the one hand, patients as recipients of nursing and, on the other, to nurses as the providers of care (HMSO 1990). Nurses perform a key role in the coordination and planning of care whilst being accountable and the utility of nursing in relation to patients recognises and respects the holistic and individual nature of each patient. The Philosophy of nursing must be reflected in nursing practice and it is through the use of the Nursing Process that nursing care is individualised whilst also considering the holistic needs of each patient. The Nursing Process provides documented evidence of the coordinated plan of care and in doing so there is an opportunity to review methods of delivering nursing care to enable nurses to strive towards the most effective and efficient implementation of nursing practice. The Science and the Art of nursing is applied throughout the Nursing Process when specialist knowledge is utilised: to identify patients problems whilst establishing a professional relationship which is supportive and informative (Assess); to plan nursing care using appropriate research (Plan); to deliver skilled nursing care (Implement) and to review nursing care to ensure the most effective and efficient care is offered (Evaluate).

Whilst it is patently true that employing the Nursing Process to nurse patients can only be taught and learned through nursing real patients, there is, nevertheless, a considerable amount which can and must be taught and learned before real patients are encountered. ***The current project uses innovations in technology to teach the concept, structure, and use of the Nursing Process.***

Teaching the concept, structure, and use of the Nursing Process through innovations in technology exposes nurse learners not only to a technology that they will be utilised in the design and development of Nursing Care Plans in the future (such as Ward Nursing Information Systems), but also exposes them to simulated clinical situations which may help learners to relate theory more closely to clinical practice. The N-CAL package has been designed so that any patient group could be used to demonstrate the use of the Nursing Process. For example, the Advanced module incorporates basic pre- and post-operative care and more advanced medical and surgical client groups

(Diabetes Mellitus with Hyperglycaemia and Ketoacidosis and Chronic Cholecystitis). The important difference between the Introductory and Advanced modules of the Nursing section is that, whereas, in the Introductory module the learners have described and demonstrated for them the concept and structure of the Nursing Process, the Advanced module actually gives learners the experience of ***applying*** the process that uses the concept and structure with specific patient groups.

Aims of Nursing Section.

The aim of the Introductory Nursing module is to ***introduce*** the ***concept*** and ***stages*** of the Nursing Process and to ***demonstrate how the Nursing Process is used*** to build a Nursing Care Plan.

The Advanced Nursing module consolidates the information presented in the Introductory module and provides the user with the ***opportunity of using the Nursing Process to build their own Nursing Care Plans*** using different client groups presented in the module.

Objectives of Nursing Section.

The behavioural objectives listed below provide the detail of how the aims of the Nursing modules are to be achieved, in doing so they provide a means against which user performance can be measured. Three specific objectives have been formed for the Introductory Nursing module and a further two specific objectives relate to the Advanced Nursing module.

On completion of the Introductory Nursing module the user will have:

1. Accessed information presented in the module in relation to the Nursing Process.

2. Completed the build up of the Nursing Care Plan demonstrated in the module.

3. Responded appropriately to the questions set within the module.

Users of this style of learning package are actively involved in the accessing of information through the HYPERTEXT facility. Thus, it is essential to ensure that this facility is utilised to gain access the details of the Nursing Process. The first objective is set so that users route through the learning module is examined to ensure that they

have explored the options available to them, for if they have chosen not to explore the HYPERTEXT facility they will not have been exposed to detailed information on the Nursing Process.
The second objective is set to ensure that users have successfully negotiated a path through the module, for in doing so they will demonstrate that they have been progressively exposed to the build up of the Nursing Care Plan.
A total of eleven questions are set at two different stages of the module. They are designed to test the users knowledge of information presented in the module. Users responses will be a measure of their knowledge. Whilst a positive response could not be specifically attributed to knowledge gain from the module, a negative response indicates that users have not gained knowledge from the Introductory Nursing module.

On completion of the Advanced Nursing module the user will have:

1. Demonstrated their computer-use skills in building a Nursing Care Plan using the information presented in the module.

2. Completed their own Nursing Care Plans in the recommended format.
The building of a Nursing Care Plan is a complex task. If users were to be successful in building their own Nursing Care Plans, not only would they have they picked up sufficient computer-use skills to enable this function (an achievement in itself) but they will have demonstrated an understanding of the Nursing Process. The first objective is designed to test this.
The second objective is designed to more appropriately test users understanding of the Nursing Process by examining the users' Care Plans in more detail to ensure that they have followed the recommended structuring of Care Plans. The final objective relates to users cognitive learning.

The details of the Nursing section objectives give a measure against which an educational outcome can be tested. Users achievement of the objectives give an indication of their learning both in terms of computer-use skills and nursing knowledge.

2. Summary

The current N-CAL package utilises many of the substantial developments which have occurred during the 1980s (developments relating to hardware and software which have been identified as WIMP / GUI / HYPERTEXT). In doing so the traditional approach to computer-use for N-CAL is replaced by a delivery system which more appropriately represents contemporary computing facilities. ***This approach attempts to exploit technological developments which have been neglected thus far by N-CAL particularly in the UK.***

Additionally, the nursing content of the package addresses the very core of nursing. If N-CAL is to be retained as a regular, integral and effective part of the curriculum of nurse education, packages that are intellectually stimulating which address themes and principles relevant throughout nursing practice and nurse education (such as, for example, the Nursing Process) should be developed. This approach to N-CAL is much more appropriate than the traditional approach that is designed to teach about discrete and unconnected parts of the curriculum.

A distinction has been made between the delivery system and the information that the package contains. This distinction is even more important when attention is directed towards evaluating the N-CAL package. Thus, the evaluations which will be reported in the following chapters aim to comprehensively evaluate the design and structure of the N-CAL package as well as the information they contain.

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Chapter 4

THE FORMATIVE EVALUATION OF THE N-CAL PACKAGE

Introduction

The following experiments report an empirical approach to the evaluation of N-CAL. The aim was to explore methods of more comprehensively evaluating the usability of the N-CAL package seeking methods hitherto not found within this area of education. No serious effort is made to use or develop a theoretical underpinning to the interactions between the user and the package. Instead, an attempt has been made to survey the different performance measures that can be taken from the interaction and identify which measures are most useful in driving the package development. Thus, it is the evaluation measures themselves that are under scrutiny and the package under construction becomes a vehicle to permit this exercise. Once an informative way of measuring the Human-Computer Interactions (the performance) has been discovered, then the data obtained from the measures can be used to begin theorising about the interactions themselves. It is not within the remit of this project to even begin to develop a theory of interaction for, what needs to be identified first is the measures which provide the detailed and informative data which accurately represents the interactions at the interface.

A total of five experiments were completed. The first three experiments took place under controlled 'laboratory' conditions presenting an opportunity to utilise detailed but labour intensive evaluation measures. Experiments four and five were completed in the 'real world' of nurse education (the classroom), as such the experiments were compromised by the limitations of the environment. There was less opportunity, therefore, to use detailed evaluation measures and the experiments were modified to suit.
The general aim of the first three experiments was to contribute to the development of the N-CAL package. Thus, the evaluations here were formative. The general aim of the last two experiments was to examine the final developed N-CAL package with those users for whom it had been designed and in the environment within which it had been designed to function. Thus, the final two experiments were summative.

Experiments four and five will be examined seperately, and will be reported in chapter five following the reports of Experiments one, two and three reported sequentially in this chapter.
Subjects for each experiment were carefully selected for their different expertise, knowledge and skills reflecting the stage of the N-CAL package evolution and the requirements of the evaluation exercises. For example, non-nurses were used to evaluate the early stages of the N-CAL package delivery system, whereas nurse educators were used at a later stage in the package development to evaluate the nursing content. A list of broad aims and objectives which are more general than behavioural objectives and of a format suggested by Klausmeier and Goodwin (1975) to facilitate decision making about educational programmes are listed for each experiment in appendix 1.

1. Experiment One.

This experiment was designed to obtain information about the delivery system. For this purpose the Tutorial section (designed to teach ways of interacting with the delivery system) was to be evaluated seperately and prior to the development of the Nursing section for, the delivery system would be used in the later Nursing section to present nursing information. Thus, in practice, an evaluation of the Tutorial section represented an evaluation at an early stage of the development of the delivery system itself. This experiment was designed to provide specific information which could be utilised in the development of the Tutorial modules and which could also be used to identify the best method of presenting the nursing information in the subsequent Nursing modules.
This experiment was designed to identify the extent to which users were quite simply able to complete the various tasks contained in the modules. Indeed the achievement of the objectives of the Tutorial section, outlined in the previous chapter, would be determined by users' completion of the individual tasks set within the Tutorial section.

The evaluation exercise was more specifically designed to identify the strengths and weaknesses of the delivery system by identifying those features of the WIMP / GUI / HYPERTEXT computing approach, described previously, which led to inappropriate use (identified as errors) or which led to less positive user preference or opinions being expressed.

Central to all the evaluations was the exploration of the process of evaluation itself to identify the extent to which the measures used were capable of providing useful information for the development of the N-CAL package.

1.1. Method

1.1.1. Apparatus and Material

The three Tutorial modules which comprised the Tutorial section (Introductory, Intermediate, and Advanced) were evaluated in this first experiment. An Apple Mac Plus with one megabyte of RAM and an eight hundred kilobyte external disc drive was used. The Mac Plus was running System 6.0.4 and the Tutorial modules were running under HyperCard version 1.2. The most basic, commonly found level of Apple Macintosh hardware and software was deliberately chosen so that comparisons that would eventually be made with N-CAL's current computing equipment would not be compromised.

1.1.2.Subjects

Twenty undergraduate volunteers from Glasgow University were recruited for this first experiment. They formed two groups, ten were inexperienced Apple Macintosh users and formed one group and ten were familiar users of Macintosh products and formed the other group. Two groups with different levels of computing experience were used to identify the extent to which both novices and experienced users would cope with the tasks set within the Tutorial module.

1.1.3. Design of Experiment

There were six different evaluation measures used in this experiment. Two concurrent measures, a computer captured trace of the users route through the modules and the other an observers commentary of users visible behaviour at the interface of the package. A third measure of errors was derived from the two concurrent measures. Finally, three retrospective measures were taken in relation to user preferences and opinions. A more detailed explanation of each of the measures will follow.

Measure One - Trace (User's human-computer interaction response protocol)

The three Tutorial modules had a trace facility incorporated with no apparent additional processing overheads. Every subject's response was automatically identified, named, time logged and filed for later analysis without interference to the package's functionality. This is an extremely rich source of information and a source that others working within evaluation are beginning to recognise as important (Kornbrot and MacLeod 1990).

This measure provided a totally objective framework of user interaction around which the other more subjective concurrent measure from the observer's commentary was arranged.

Measure Two - Observer's Commentary (User's visible behavioural protocol)

This measure was used to capture the subject's informal interaction with the package. To assist in collecting this information the observer had a hard copy of each individual screen which exactly corresponded to the perceptual information with which the subject was confronted. There were approximately sixty different screens for which a checklist of the subject's expected actions and responses were identified in relation to the tasks set by the different screens of information. The observer's hard copy of the screens contained the checklist of the subject's expected actions and responses and a free-note section. The observer was required to record on the checklist how the subject performed in relation to the specific tasks set for each individual screenful of information. The free-note section allowed the observer to record any unforeseen action or response.

Completion of the individual tasks represented the means to achieving the packages's objectives (described in Chapter three), thus the subject's ability to perform these tasks was a measure of whether the objectives and the overall goals of the package had been achieved.

Measure Three - Errors

An error was identified as any action which was not the indicated action as determined by the information displayed on a particular screen. Errors were identified from the trace facility and were subsequently assigned to a category using the information from the observer's commentary. Thus, this measure was derived from both concurrent measures of the trace and the observer's commentary.

Errors were assigned to one of five categories,

i) Navigation errors when the wrong navigation icon was used to move around the package,

ii) Instructional errors, a result of not reading or apprehending the instructions,

iii) Task errors, a result of misunderstanding instructions or poor comprehension identified when subjects did not recognise the tasks to be completed,

iv) Mouse / Button errors when the mouse was clicked inappropriately, either the subject did not know where to click or clicked uncontrollably and

v) Incompletion errors, when tasks indicated on the screen were not completed.

It was expected that the error information would give a quantifiable result, not only of where and how often errors occur but also what errors were made.

Measure Four - Screen Preference

At the end of each module of the Tutorial section subjects chose their first and second preferred screens according to seven different judgemental criteria (see table 1). Six of the seven judgemental criteria were opposite pairs, a final score for each subject was calculated as an aggregate from the three pairs of opposite criteria and the remaining single criteria was left uncombined, thus four different measures of screen preference were constructed (see table 1). To remind the subjects of the different screens wall mounted hard copies of the all the screens (approximately twenty screens in each module)were grouped for each of the different modules - Introductory, Intermediate and Advanced modules.

The information generated here was designed to be used with a classification of screens according to interactive or instructional presentations. Instructional screens were those screens where the only response requested by the subject was to initiate a move to the next screen, whereas interactional screens were those screens which required the subject to respond in some other way before initiating a move.

Instructional screens were representative of conventional N-CAL presentations (that is an electronic textbook) whereas interactive screens were more representative of Hypertext facilities and thus resembled the changing nature of computing and the style of computing that this project was designed to explore.

Using the criteria described, the number of instructional versus interactional screens preferred by each subject was recorded for each module of the Tutorial section. The information generated here should point to which style of package construction was

Table 1. Measuring Screen Preference - Experiment one.

A. The seven judgemental criteria used:

Useful, Useless, Interesting, Boring, Confusing, Straightforward, Stimulating.

B. Combining the judgemental criteria for a more robust analysis:

USEFUL: combining Useful and Useless.

INTERESTING: combining Interesting and Boring.

CONFUSING: combining Confusing and Straightforward.

STIMULATING: remaining uncombined.

C. Method of scoring

Example of a combination to produce a USEFUL preference score for one user:

Useful choice: 5 interactive screens to 1 instructional screen (two choices - all modules).

Useless choice: 2 interactive screens to 4 instructional screens (two choices - all modules).

USEFUL choice is equivalent to: 9 (5+4) interactive to 3 (1+2) instructional screens.

Thus the user displays a preference for interactive screens preferred by the users.

Measure Five - Feature Preferences

On completion of the Tutorial section subject s ranked fourteen different features of the package according to three judgemental criteria of Usefulness, Memorability and Likeability. The features typified the WIMP / GUI / HYPERTEXT approach (see table 2) and each feature was written on a separate card with a brief definition to avoid ambiguity. Subjects were requested to sort the cards three times according to the three different judgemental criteria and the feature ranked first was given a score of one with descending features scored correspondingly. A total score for each feature according to each criteria was obtained by adding the individual scores from all the subjects. This information identified the subject's preference for different features for the WIMP / GUI / HYPERTEXT approach. Thus, future package development could incorporate those features which were preferred.

Measure Six - Global Attitudes

On completion of the Tutorial section the subject's attitudes towards the package as a whole were measured using the Attitude toward Computer Assisted Instruction (CAI) Semantic Differential Tool designed and validated by Allen (1986). This questionnaire uses fourteen bi-polar dimensions relating to CAL, which could be aggregated into three major dimensions of comfort, creativity and function. Subjects were requested to rate their attitudes on each of the fourteen dimensions using a seven-point scale. These scores were then combined into the three major dimensions. Scores above the midpoint of four represented negative attitudes whereas scores below the midpoint were positive.

The information obtained from this questionnaire allowed some statement to be made about the subject's attitudes towards the package as whole.

Casual Debriefing

At the end of the session before any of the retrospective measures were taken users' were given the opportunity to comment on any of the modules in the Tutorial section.

Measures one to three represent objective user performance measures, whereas measures four to six are subjective measures based on user opinions. The extent to which the measures constitute formative evaluators to provide useful data for the continued construction of the N-CAL package was under examination.

Table 2. Definitions of Delivery System Features - Experiments one, two and three.

Keyboard Absence - From an early stage the keyboard was not used at all.
Navigation Buttons - This refered to the features through which the user could move to different places in the package ie. back, forward, to the start or to the home base.
Mouse Moving - This refered to moving the finger pointer around the screen using the mouse.
Pull-down Menus - This refered to the overlaying windows of additional information which was displayed under a button. For example, a choice could be made from the list of options to describe yourself and others.
Mouse Pressing - This refered to clicking the mouse up and down in order that an effect be conveyed to the computer.
Screen Presentation - There were a variety of text, graphics and backgrounds used throughout the package.
Responsiveness - The responses were of an informal, chatty nature.
Text boxes - This refered to the use of text throughout the package.
Icons - This refered to the buttons that had pictures or symbols on them.
Radio Buttons - These were the round buttons that could be switched on or off. They only allowed the user to make a single choice.
Programme Thermometer - Remember the picture of the thermometer, it gave an indi- cation of where and how far through the module the user had progressed.
Normal Buttons - This refered to the buttons with words on them.
Check Buttons - This refered to the square buttons that allowed the user to choose more than one option.
Screen Clarity - The definition of text and graphics on the screen.

1.1.4.Procedure

The subjects were sat in front of the Apple MacPlus computer at the first screen of the Introductory module of the Tutorial section and then left to follow the instructions presented within the modules. The trace facility was permanently switched on. The observer sat unobtrusively nearby with the checklist for each screenful of information on which to record measure two. On completion of each module of the Tutorial section the observer requested users to state their Screen Preference for the module they had just completed and the wall-mounted hard copies of the screens were used for reference.

1.2. Results of Experiment One

The results will be listed for each evaluation measure followed by a preliminary discussion of the results in relation to the aims and objectives of this experiment (listed in appendix 1).

Errors

The total number of errors (and the percentage number) made by all subjects in each of the five categories were combined for each of the three modules of the Tutorial section and are listed in table 3. There were reliable differences found between the categories of errors (Friedman's analysis of variance) and Wilcoxon's matched-pair signed-ranks test was used to establish where the reliable differences were located (a non-parametric rather than a parametric test was carried out because of the variability of the scores within each category of error. Througout the remainder of the results, where non-parametric tests are used it is for this reason). Excluding the comparison between the Navigation and Mouse / Button errors, there were reliable differences with the number of errors in each of the remaining four categories (see table 3) and reliably more Incompletion errors were made than any other category of error. A more detailed analysis showed that 80% of the Incompletion errors were in the Advanced module Of the total number of errors made on sixty possible screens in the Tutorial section, seventy six percent of the errors were made on eight screens, that is three screens from each of the Introductory and Intermediate modules and two screens from the Advanced module.

There were no reliable differences found between the experienced-Mac group of subjects and the novice-Mac group of subjects.

Table 3. Category of Errors Made - Experiment one.

Category	No. Errors	% Errors
Incompletion	56	43
Navigation	30	23
Mouse/Button	28	22
Instructional	13	10
Task	2	0

Note: Friedman's analysis of variance shows Friedman's Chi = 41.2, r=20, k=5, p<0.001for differences between categories of errors.

Wilcoxon matched-pair signed-rank test shows reliable differences (p<0.05 two-tailed) between any of the four grouped category of errors, above (the four groups are demarcated by the lines).

Time

The subjects took an average of 29.3 minutes to complete the Tutorial section (standard deviation of 5.7 minutes). The difference between the two groups was small and unreliable.
The total number of errors made by each subject was correlated with their time to complete the Tutorial section. The correlation was low, positive and unreliable (Pearson product-moment correlation test $r=0.26$, $p=0.068$).

Preference for Instructional vs Interactive Screens

Subjects reliably preferred Interactive screens according to three of the judgemental criteria of Usefulness, Stimulating and Interesting. Details of the method used to score subjects' choices are recorded in table 1 and the results of the statistical analysis (sign test) which compared the number of subjects with a preference for interactive screens with the number of subjects with a preference for instructional screens are recorded in table 4. According to the judgemental criteria Stimulating, Useful, interesting or Confusing, Interactive screens were reliably chosen over Instructional screens.
No reliable differences were found between the two groups of subjects.

Preference for Delivery System Features

Across the three judgemental criteria Useful, Likeable and Memorable there were reliable differences between the preferences for the fourteen features used to represent this style of computing (Friedmans' Chi 69, 72 and 38, $r=20$, $k=14$, $p< 0.05$, Table 5 records the results of the Friedman's analysis of variance). A group of the same six features (Keyboard absence, Mouse Moving, Mouse Pressing, Navigation Buttons, Pull-down Menus and Responsiveness) were most preferred over all three of the judgemental criteria although not always in the same order and a group of the same two features (Screen Clarity and Normal Buttons) were the least preferred features over the three judgemental criteria (see figure 1 for the mean values). Using a Wilcoxon's matched-pair signed-ranks test with fourteen features produces a very large number of multiple comparisons which are difficult to report, the results are thus summarised for clarity. There are reliable differences between any of the features in the group most preffered and any of the features in the group least preferred ($p<0.05$) with the exception of Responsiveness for the criterion Useful.
Subjects' preference for features were more distinct for the judgemental criteria of Useful and Likeable than for the criterion Memorable (this is reflected in the

Table 4. Preferences for Screen Type - Experiment one.

The number of users choosing interactive screens as the preferred screen type:

Judgemental Criterion	users	N	p-value
Stimulating	19	19	<0.004
Useful	12	15	0.036
Interesting	16	17	0.002
Confusing	14	18	0.03

Note: N=number of users with a measured preference. Sign Test p-values are two-tailed.

Table 5. Preferences for Delivery System Features - Experiment one.

The reliability of users' preference differences for package features

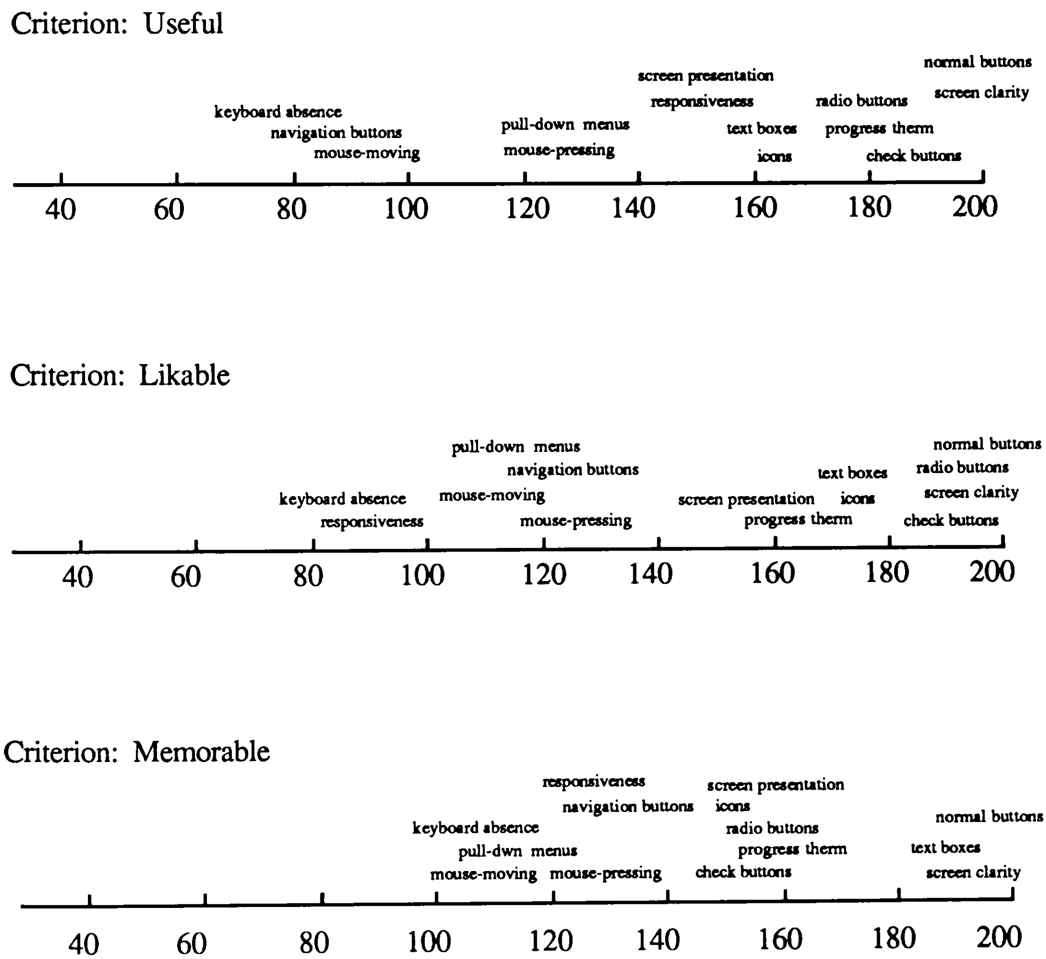
Judgemental Criterion	Friedman's Chi	p-value
Useful	69	<0.05
Likable	62	<0.05
Memorable	38	<0.05

Note: For Friedman's analysis of variance $r=20$ and $k=14$.

For these values of r and k the values of Friedman's Chi have been interpreted through extrapolation from critical value tables where $k=10$. Whilst the p values remain indeterminate it is certainly less than 0.05.

Figure 1.

Preference Scores for Delivery System Features - Experiment one.



Total score for each package feature for each criterion (lowest score, most preferred).

Friedman's Chi). However, a more detailed analysis of the two groups of subjects separately showed this to be a result of combining the two groups; for the Mac-novice groups' preference for the features using the judgemental criterion Memorable was comparable to the results for the other two judgemental criteria (Friedman's Chi, 28) whereas the Mac-experienced groups' preference for this criterion was not so distinct (Friedman's Chi, 18). There was no group assymetry detected for the remaining two judgemental criteria Useful or Likeable.

Global Attitude towards the Package

The number of subjects with positive attitudes towards the package across the fourteen dimensions of attitude combined was reliably more than subjects with negative attitudes (sign test $p<0.002$ two-tailed). The same result was found for the three superordinate functions of Comfort, Creativity and Functionality (see table 6). There were no reliable differences detected between the two groups of subjects.

Casual Debriefing

Subjects commented that the Advanced module was repetitive of the content presented in the Intermediate module. Reliably more subjects stated this than did not (15/20, $p<0.04$ two tailed sign test).

1.2.1. Preliminary Discussion

The results will now be considered against the broad aim and the more specific objectives of this experiment with a focus on identifying the extent to which the measures provided useful information for the development of the N-CAL package.

Were users able to complete the Tutorial section? All subjects completed the Tutorial section and reported positive attitudes towards the package, but, whilst the attitudinal information was encouraging it is difficult to imagine any changes which could have been made on the basis of this information. Indeed, had the attitudes been neutral or negative it would merely be an indication that something was not right. Thus other measures are required to give more useful information for the development of this package and N-CAL in general.

Did the users complete the specific tasks set within the package? The greatest number of errors were Incompletion errors (forty three percent, reliably more

Table 6. Global Attitudes towards the N-CAL Package - Experiment one.

The number of users with positive attitudes towards the package:

Dimension	users	N	p-value
Comfort	18	18	<0.002
Creativity	14	15	<0.008
Functionality	19	19	<0.002
Combined	18	18	<0.002

Note: N=number of users with a non-neutral attitude. Sign Test p-values are two-tailed.

than any other category), so whilst the subjects completed the package as a whole there were specific tasks identified from this category of errors which were not completed. A more detailed analysis showed that most of the Incompletion errors occurred in the Advanced module and a closer examination of this was most instructive.

The purpose of the Advanced module was to introduce and provide practise in using Pull-down menus as a means of selecting an option rather than typing at the keyboard or selecting from a conventional menu at the keyboard. To introduce this task subjects were exposed to a task which had been presented in the Intermediate module where they described themselves by checking buttons opposite menu items. It was intended that by contrasting this identical task using a different method of selection (Pull-down menus) subjects would clearly see the advantages of using Pull-down menus in the Advanced module. Educational theory suggests that new knowledge is more readily acquired by building on existing knowledge and an attempt was made to engender this by using a familiar task on which subjects could build. However, the error data made it clear that subjects were not prepared to complete the reimplimented task as they found it repetitious. As a consequence they were poorly exposed to using Pull-down menus. This finding was supported by the users' informal comments referring to the repetitive nature of the Advanced module. Thus, the error information did, in this case, identify a serious defect in the Advanced module of the Tutorial section which might not otherwise have been identified.

Whilst performance measures used as an evaluation tool gave hard evidence, care was needed when using the data for it may have proved to be deceptive. For example, if a subject generated errors in an effort to complete the package quickly, then the nature and the location of the errors would have been misleading. Evidence of a speed / error trade-off would have indicated this (where the subjects completing the package quickest make the most errors and the slowest make the least errors, producing a negatively-correlated relationship). The error data generated in this experiment did not exhibit this phenomenon for there was no reliable correlation between the number of errors made by a subject and the time the subject took to complete the package.

Which features of the WIMP / GUI / HYPERTEXT computing style led to more positive attitudes? The preference information clearly identified that subjects preferred to Interact rather than be Instructed by the learning package. Reliably more subjects identified the Interactive screens as more Stimulating, Useful, Interesting and Confusing. The final observation is of little consequence, since considerable effort was made to ensure that Instructional screens were clear and without ambiquity whilst the very nature of Interactive screens identified them as more confusing. The internal validity of the preference for Interactive screens was strengthened by the feature preference information, where subjects reported a preference for individual features which reflected an interactive style of computing. Four of the features identified as being in the top group of six underpin active interaction (Mouse moving, Mouse pressing, Pull-down menus, and Responsiveness). Whilst Mouse moving, Mouse pressing and Navigation buttons were also present in the Instructional screens they were only used to move on from the current screen, and not for interacting with the current screen. These features were utilised to a much greater extent in the Interactive screens to acquire more information, indeed they represented the means through which the interaction occurred. If subjects had reported a preference for those features which were clearly non-interactive then the internal validity of the preference for the interactive style of computing would have been questionable. The feature preference information was valuable for the development of the package, for it provided a rational for raising the profile of those features preferred whilst lowering the profile of those features least preferred.

Which features of this computing style led to inappropriate use? Of the five categories of errors, Task errors were negligible and Instructional errors although reliably more prominent were still low in number. This suggested that information apprehension (instructional errors) and information comprehension (task errors) was not compromised by the design of the delivery system. Significantly more Navigation errors and Mouse / Button errors were demonstrated by confusion in where to click with the mouse pointer. Thus, the need to specifically improve the button pressing areas on the screen and make them more easily identified was demonstrated by these two classes of errors. In addition to the Incompletion errors identified earlier, associated with the Advanced module, the remaining Incompletion errors were found to be associated with three screens from each of the other two modules. Thus the attention of the developer can be readily focussed on those screens which generated errors.

Measures of performance provided hard evidence of where and how often errors occur. Through paying attention to this information one would reasonably expect that the package would be improved. However, whilst the identification of the concentration of errors and their location is of benefit, it is not necessarily clear ***why*** the errors occurred. Consequently, the changes needed to reduce the error count at a particular screen were not necessarily clear. Later experiments were designed to address this ambiguity.

Summary

This experiment moved closer to addressing the problem of reluctant or inefficient computer-use, seen within N-CAL, by concentrating on the ***usability*** of an N-CAL package. Indeed, the evaluation measures used in this first experiment have provided in some detail an account of user interaction at the interface of the delivery system through their use of the Tutorial section.

Errors were assosciatd with specific screens and from the range of features available users preferences were identified. Performance measures were demonstrated here to be of much more value to the development of the N-CAL package rather than global attitude measures.

Errors are a quantifiable and objective manifestation of cognitive difficulties, but errors represent extreme difficulties and it was not always easy to decide why the error occurred. Indeed, this depth of analysis was very rarely reclaimable from the observer's commentary. Thus, in an attempt to obtain more detailed information in relation to the error categories the procedure known as verbal protocol analysis was used in Experiment two to help disambiguate the information obtained from the trace and the observer's commentary. ***The successful identification of errors in relation to the error category was felt to be crucial to an informative evaluation of the N-CAL package*** and it was expected that the analysis of verbal protocols would be of greater value in identifying why particular responses were made.

2. Experi ment Two

This experiment represents the next logical step in the series of evaluations to contribute to the N-CAL package development by expanding the scope of the evaluation in small stages. It was now appropriate to incorporate the Introductory module of the Nursing section of the N-CAL package to identify the extent to which users were able to apply what they had learned about the delivery system to access the nursing information contained within this section. In addition, subjects with a considerably different profile of experience were used to elicit data in relation to the nursing information as well as the delivery system.

Whilst this experiment was also designed to identify whether subjects were able to complete the tasks set in the package, this experiment was more specifically designed to identify whether the subjects were able to complete the Nursing module, for this would be a measure of whether subjects were exposed to sufficient computer-use skills in the Tutorial section to enable them to use the delivery system of the Nursing module. An additional objective of the experiment was to determine the accuracy of the nursing content.

This experiment was also designed to identify the strengths and weaknesses of the delivery system but this time as perceived by subjects who had detailed knowledge of how the delivery system would be used in the classroom and detailed knowledge of the learners who will use it. In addition those features of the computing style which led to errors would be more objectively identified by eliciting information as to why the specific errors occurred through the introduction of an additional performance measure.

Central to the series of evaluations was the exploration of the process of formative evaluation to identify the extent to which the different measures were capable of providing useful information to contribute to the development of the N-CAL package and N-CAL in general.

2.1.Method

2.1.1. Subjects

Nurse educators were recruited as subjects with experience of the computing facilities (Acorn BBC micro computer) available within nurse education and a good knowledge of the educational scenario in which this N-CAL package was designed to operate.

Eleven subjects from the nurse teaching staff of the South College of Nursing, Glasgow participated in this experiment. One subject was excluded from the results, for this subject completed less than half of the Nursing module due to time constraints outwith the control of the experimenter.

All subjects were actively involved in teaching the Nursing Process to nurse learners in basic nurse education and / or trained nurses in Continuing Nurse Education and had, therefore, a thorough knowledge of the objectives of the respective courses. It was more appropriate to evaluate the Introductory Nursing module with this group of subjects for their specific knowledge could be used to evaluate the nursing content of this module.

The nurse educators were Macintosh-inexperienced, but experiment one reliably demonstrated previous experience to be unimportant. The extent to which the subjects were able to complete the Nursing module would be a substantial indication of whether they had acquired sufficient computer-use skills from the Tutorial section. Indeed this group of subjects were felt to be a better indication of a subjects ability to use the package since the cognitive load the Nursing module put on the nurse educators would be less than that put on nurse learners, who would not only need to negotiate a path through the module but would also be attempting to understand the nursing content. This group of subjects were chosen for having substantially different skills and knowledge from those subjects utilised in Experiment one, thus widening the scope of the evaluation in the way that Benton (1989) suggested.

2.1.2. Apparatus and Materials

The Introductory and Intermediate modules of the Tutorial section and the Introductory module of the Nursing section were evaluated in this experiment. The Advanced module of the Tutorial section was not used in this experiment for the nature of the changes required to this module were now well defined. The specific concept of Pull-down menus, which the Advanced module was designed to teach, was not utilised in Introductory Nursing module, as such it served no purpose to expose this group of subjects to the Advanced module.

The package ran on an Apple MacPlus with one megabyte of RAM and a twenty megabyte hard disc. Apple system 6.0.4 was used running HyperCard version 1.2.

2.1.3. Design

The evaluation measures used were consistant with the first experiment other than the measure of screen preference, which was no longer required, and one feature of the WIMP / GUI / HYPERTEXT approach (Pull-down menus) was not included for it was not represented in the package used for the current evaluation. A third concurrent measure was added to the range of evaluation measures collected in this experiment - Verbal Protocols. During the last thirty years Cognitive Psychology has developed a methodology enabling data obtained from verbal protocols to often be as objective and valid as observable behavioural data but with the potential of being much more informative. Concurrent verbal protocols can reveal in remarkable detail what information the user was attending to while performing the task at the computer, and by revealing this information, can provide a picture of the way in which the task was performed (Ericsson and Simon 1984). Consequently not just whether an error occurred can be identified, but there is a chance of determining why. In addition, difficulties that had not yet achieved the status of errors, but nevertheless, could hold back progress, could also be identified.

Verbal Protocols

Verbal protocols were obtained from users by placing a tape recorder in front of the hard disc to record the subjects verbal comments, the mouse clicks and also the processing sounds of the hard disc of the computer.

The subjects had been instructed to provide a detailed running commentary of their thoughts driving their actions and their response to the information presented. The subjects' concurrent verbalisations were recorded on tape and later transcribed and analysed. The purpose of the current verbal protocol analysis was to identify difficulties (distinct from errors) experienced by the subjects and to provide a measure which should help to disambiguate the coding of the errors. Verbal protocols would also be used to identify comments in respect of the nursing content in relation to the Nursing module.

To take advantage of the verbal protocols a method of structuring or encoding the data (now available as a transcript) was developed. The transcript was first divided into segments where each segment represented the verbalisations in response to a single screenful of information. The division of the segments from the tape recordings was assisted by listening for the mouse clicks and the processing noises of the computer. The identity of each segment was verified by checking the observer's commentary sheets (hard copies of the perceptual information the subjects were confronted with) for corresponding information in the content of the subjects verbalisation. The next

step was to develop a method of encoding the segments and to define the transcribed statements according to the codes or categories. For this purpose three categories based on activity descriptions were found to be sufficient:
Preparation (A) - where subjects were reading and trying to understand
Interpreting (B) - where subjects were checking understanding and
Production (C) - where subjects were carrying out the tasks relating to A and B.
The descriptive category (C) had the qualifiiers correct, incorrect, incomplete or don't know associated with them.
Verbal protocols can be analysed in terms of the frequency of each coding category for different segments of the protocol. In this way verbal statements from different subjects were combined for summary purposes with the potential of providing evidence of difficulties encountered by a number of subjects at the same screenful of information. It was also anticipated that the verbal protocols would help in more accurately identifying the source of the errors detected from the analysis of the trace and observer's commentary.
In addition to the categories described based on activity descriptions a further category of Comments in relation to the nursing content was also coded with six qualifiers associated with the Comment: Complete, Incomplete, Correct, Incorrect, Positive or Negative.

2.1.4. Procedure

The subjects were again sat in front of the Apple MacPlus computer at the first screen of the Introductory module of the Tutorial section and left to continue through the N-CAL package by following the instructions presented within the package. The trace facility was operational. The observer sat unobtrusively nearby with the relevent checklist and a tape recorder was switched on and placed in front of the hard disc opposite the subjects. On completion of each of the modules subjects were reminded by the observer to constantly verbalise the thoughts driving their actions.

2.2. Results

The results will be listed in the first instance according to the measures used followed by a preliminary discussion of the results in relation to the aims and objectives of this experiment (see appendix 1).

Errors

The number of errors in each of the five categories (combined for the Introductory and Intermediate modules of the Tutorial section) are recorded in table 7. Reliable differences between the categories of errors were detected using the Friedman's analysis of variance and the location of these differences were located using a Wilcoxon's matched-pair signed-rank test and are also recorded in table 7. Mouse / button errors were reliably more prominent than any other category of errors and Instructional and Task errors were least prominent. The greater proportion of the errors were associated with the same six screens identified in Experiment one.
A total of sixty six errors were made by all subjects in the Introductory Nursing module. Forty six percent of all errors were made on five screens of information (from a total of sixty screens) and the remaining errors were randomely distributed across a further eighteen screens. The number of errors in each of the five categories are recorded in table 8. Reliable differences were found between categories and the location of these differences are also recorded in table 8. Reliably more Incompletion errors and Mouse / button errors were made and Task and Instructional errors were reliably less prominent. Within the category Incompletion errors, sixty nine percent of these occurred on three screens of the Introductory Nursing module.

Time

Subjects took an average of 27 minutes (standard deviation 5.1 minutes) to complete the Introductory and Intermediate modules of the Tutorial section and 31.3 minutes (standard deviation 7.1 minutes.) to complete the Introductory Nursing module. The correlation between the total number of errors made by subjects using the two modules of the Tutorial section and the time taken to complete these modules (speed / error trade off) was positive and reliable (Pearson product-moment correlation test, $r=0.77$, $p<0.05$). The correlation of a speed / error trade off between the total number of errors made whilst using the Introductory Nursing module and the time taken to complete this module was negative but not reliable. (Pearson product-moment correlation test, $r= -0.27$, $p>0.1$)

Preference for Delivery System Features

Across the three judgemental criteria Useful, Likeable and Memorable there were reliable differences between the preferences for the thirteen features used to present this style of computing (Friedmans' Chi 20, 17 and 17, $r=10$, $k=13$, $p< 0.05$).

Table 7. Category of Errors Made during the Tutorial section - Experiment two.

Category	No. Errors	% Errors
Mouse/Button	50	51
Navigation	24	25
Incompletion	11	11
Instructional	9	9
Task	3	3

Note: Friedman's analysis of variance shows Friedman's Chi = 31.8, r=10, k=5, $p<0.01$ for differences between categories of errors.

Wilcoxon matched-pair signed-rank tests shows reliable differences ($p<0.05$) between all of the above categories except Task-Instructional and Instructional-Incompletion.

This table represents the errors for 10 users over two modules (not 20 users over 3 modules as Experiment one).

Table 8. Category of Errors Made during the Introductory Nursing module - Experiment two.

Category	No. Errors	% Errors
Incompletion	26	39
Mouse/Button	23	35
Navigation	15	23
Task	2	3
Instructional	0	0

Note: Friedman's analysis of variance shows Friedman's Chi =24.9, r=10, k=5, p<0.01 for differences between categories of errors.

Wilcoxon matched-pair signed-rank tests shows reliable differences (p<0.05) between the two grouped categories of errors (demarcated by the lines) and no reliable differences between the categories of errors within the the two groups.

Extreme pairwise comparisons were carried out using Wilcoxon's matched-pair signed-rank test. The feature Mouse Moving was most preferred across the three judgemental criteria and Screen Clarity was the feature least preferred ($p<0.05$). Groupings of features according to most and least preferred was not as distinct as in Experiment one, indeed Keyboard Absence was rated as a preferred feature only for the criterion Memorable but in contrast to this it appeared in the group of least preferred features for the criteria Useful and Likeable. Normal buttons appeared in the group of feaures least preferred for the criteria Likeable and Memorable but was not reliably different to the group most preferred for the criterion Useful. Figure two illustrated the mean values of the preference features for all subjects across the three criteria.

Global Attitudes towards the Package

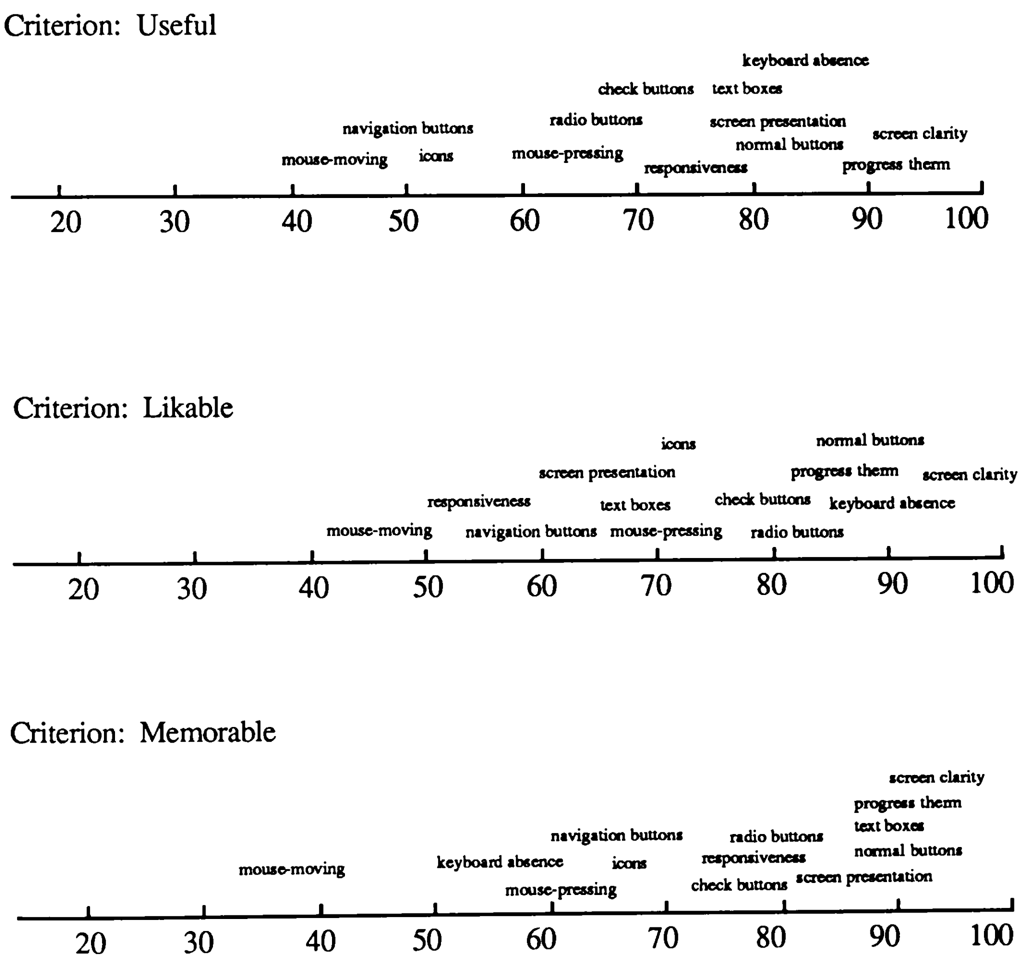
In common with Experiment one reliably more users (indeed all users) had positive attitudes towards the package than negative ones for all dimensions. All users demonstrated positive attitudes (sign test $p<0.01$two tailed). The package was rated by all nurse education informed subjects as ‘meaningful’ and ‘appropriate’.

Verbal Protocol Analysis

Using the classification system described earlier there were a total of eighty nine difficulties experienced by subjects during the Introductory and Intermediate modules of the Tutorial section and a total of forty two difficulties experienced by subjects during the Introductory Nursing module. In the two modules of the Tutorial section there were slightly more Production difficulties (thirty three or thirty seven percent) than either Interpretation (twenty six or twenty nine percent) or Preparation (thirty or thirty four percent) difficulties but the differences were not reliable (Friedman's Chi = 0.9, $p>0.05$). The analysis of the Nursing module was quite different, for Production difficulties (thirty nine or ninety three percent) were reliably more prominant than either Interpretation or Preparation difficulties (Friedmans Chi =11.4, $p<0.01$). The location of the reliable difference is unambiguously between the difficulty category Production and the other two categories of difficulties.

A comparison of the difficulties identified from the verbal protocols with the error data revealed that in the Tutorial section the bulk of difficulties were associated with the same small number of screens. The one notable exception where subjects generated errors but a difficulty count of zero was expressed for this screen, reflected subjects

Figure 2. Preference Scores for Delivery System Features - Experiment two.



Total score for each package feature for each criterion (lowest score, most preferred).

making errors without knowledge of doing so, thus they did not experience any difficulty with this screen. The small number of difficulties identified whilst subjects worked through the Nursing module were randomly distributed over a large number of screens and no systematic statistical analysis is therefore appropriate.

The classification of Comments in relation to the nursing content of the Introductory Nursing module revealed a total of one hundred and nineteen Comments (see table 9). This data has been treated qualitatively rather than quantatively and as such it is not intended that generalisable statements be made. Table 9 represents a profile of the Comments and their frequency but, a statistical analysis of this would be entirely inappropriate. However, the value of this data has been in flusing out Comments relating to the nursing content being Incomplete or Innappropriate and these were identified with the specific screen of information which led to the Comment being verbalised. For example, in one of the multiple choice questions seven subjects experienced difficulty in choosing the correct answer. This difficulty was Commented as the nursing information being Inappropriate and this was attributed to ambiguity in the wording of alternate answers.

Classifying the verbal protocols according to activity descriptions of Preparation, Interpretation and Production revealed its own problems, for if the Production was not easily executed then the difficulty was labelled as a Production difficulty. However, it became clear that the source of the difficulty (the reason for including verbal protocols) was not identified by this analysis. Thus, in an attempt to capture this important piece of information an analysis of the difficulties associated with ***objects*** encountered in the N-CAL package was carried out. The objects referred to here are the different forms of presenting information, described in chapter three, such as different icons, pictures and text overlayed by screen buttons.

With this classification, nearly half of the difficulties (forty six percent) were encountered with the object 'Text Boxes' containing textual information in the Tutorial section. Some of these difficulties would have been misleadingly categorised in terms of action descriptions as Production difficulties. The remaining difficulties were distributed across a range of specific icons and buttons which provided information for the developer but did not provide any general principles. The distribution of the difficulties identified from the verbal protocols of subjects whilst using the Nursing module was evenly distributed across the various objects.

Table 9. Comments elicited from the Verbal Protocols relating to the Content of the Introductory Nursing module - Experiment two.

Comment	Nos	%
Appropriate	15	1
Innappropriate	22	18
Incomplete	21	18
Complete	3	3
Positive	44	37
Negative	14	12

This table represents a profile of the Comments and their frequency. No statistical analysis was carried out this data, for it would be entirely innapropriate.

General Comments

All subjects were shown a copy of the handout produced from the N-CAL package and asked whether they felt it was appropriate for learners following completion of the N-CAL package. All subjects reported the handout to be relevent and appropriate for learners.

2.2.1. Preliminary Discussion

To a very large extent the results of Experiment two using subjects who were nurse education informed concur with the results of Experiment one.
The results will now be considered against the broad aim and the more specific objectives of this experiment with a focus on identifying the extent to which the measures provided useful information for the development of the N-CAL package.

Were the subjects able to complete the package? All subjects completed the Tutorial section and were then able to complete the Introductory Nursing module. Thus, the Tutorial section was succesful in teaching about the delivery system, for subjects were able to use the system to access the nursing information and this was demonstrated in their ability to complete the Nursing module. Global attititudes were firmly positive. Although this is encouraging, once again, measuring attitudes did not provide any information which could contribute to the development of the package under construction.

Were the subjects able to complete the tasks set within the modules? Incompletion errors were reduced in this experiment largely as a result of this group not receiving the Advanced module of the Tutorial section in which the majority of Incompletion errors were generated in the first experiment. The number of Incompletion errors was now small during the Tutorial section and within the Nursing module a concentration of the Incompletion errors occurred on three screens of information. Unfortunately the reasons why the tasks were not completed was not reclaimable from the verbal protocols, in this instance, for only a small number of difficulties were identified during the Nursing module and these were randomly distributed over a large number of screens. Users did not express a difficulty if they were unaware of making an error and some of the Incompletion errors identified from the trace and the observers commentary were not identified as difficulties by users in their verbal comments. Indeed this is a feature of HYPERTEXT for users may choose not to explore the detail of the information presented on the screen and using subjects with considerable knowledge of the nursing content of the N-CAL package may have compounded their reluctance as users to explore all the options available to them. However, this still represents a significant problem if users are not exposed to the detail of information of the N-CAL package intended by the author. Whilst it was felt that users should be free to choose whether they explore related information within the N-CAL package, information which is crucial to the overall understanding of the N-CAL package content should be presented in such a way that users are unable to progress until they have explored the crucial information. User performance measures have been instrumental in identifying where tasks were not completed within the N-CAL package and at one of the screens six subjects did not complete the task of exploring related nursing information which was felt to be crucial to the overall understanding of the nursing information.

Was the nursing information contained within the Introductory Nursing module accurate? The global opinions of nurse education informed users were that the package was 'meaningful' and 'appropriate' but, whilst this is encouraging, global ratings such as this do not provide any specific information which is useful to the development of the package. The analysis of the verbal protocols, however, was much more informative, for the verbalisations of those educators whose job it is to teach the content of the Introductory Nursing module identified those screens on which the information presented was inappropriate or incomplete, thus pointing to deficiencies in the information which could be rectified in the development. For example, seven subjects commented that the nursing information content was inappropriate at one of the eleven multiple choice questions, for the alternate answers were ambiguous. Thus, evidence and reasons for a developmental change in the content of the package were identified from the verbal protocols. In addition the handout produced from the N-CAL package was felt by those nursing informed subjects to be relevent and appropriate for learners.

What features of the package led to more positive attitudes? The features of the WIMP / HYPERTEXT style of computing most and least preferred were less distinct than those expressed in Experiment one. Mouse Moving was the single feature most preferred across all three of the judgemental criteria and this does represent the very means through which users interact with the package. Screen

Clarity and Normal Buttons were again the features least preferred although for the criterion Useful Normal Buttons was not reliably rated in either category. The ratings of the feature Keyboard Abs ence does stand in marked contrast to Experiment one, for although it was Memorable to nurse tutors it was not Liked nor was it regarded as Useful. Very little importance was attached to this result for the nurse tutors were familiar with the keyboard as a method of inputting information from their extensive use of the BBC and no replacement for that important function was made explicit to the nurse tutors for, they had not been exposed to the feature Pull-down menus as an alternative method to inputting text from the keyboard.

What features of the package led to errors or difficulties? The error data from the Tutorial section did appear to differ from the data in experiment one but the differences are easily explained in terms of the Incompletion errors as described earlier. Task and Instructional errors were few throughout the modules and the number of Navigation errors were equivalent concurring with the error data generated from Experiment one. Indeed the concentration of errors over a small number of screens in the Tutorial section supported the observations in terms of module development reached in the first Experiment.

The number of Mouse / button errors experienced by the nurse tutors was much greater than that identified in Experiment one, particularly prominent in the Tutorial section where this category of error was reliably more than any other category. In the Nursing module the number of Mouse / button errors was equivalent to the category of errors Incompletion and Navigation and reflected a distribution of errors similar to that identified in Experiment one. The increase in errors in the Tutorial section for this group of subjects could perhaps be explained by the greater cognitive load placed upon these subjects as a consequence of having to provide concurrent verbal protocols. As a result the performance data was potentially much more friable than in the earlier experiment. The need to measure the extent to which the time to complete the N-CAL package was traded off against accuracy in terms of error data was even more important than in Experiment one. A speed accuracy trade-off would be indicated by a reliably negative correlation but there was no such effect and the status of the error data was commensurately elevated. Indeed, the correlation was reliably positive in the Tutorial section.

Verbal protocols were recruited as an evaluation method to help identify more precisely the source of errors. The extent to which verbal protocols were capable of providing

information over and above that of the error data was under evaluation.
The concentration of difficulties in the Tutorial section identified from the the verbal protocols coincided with the concentration of errors, thus the internal validity of both measures was increased. However, the source of the errors or difficulties was found to be disimilar across the two measures, for Production difficulties represented one third of the difficulties in the Tutorial section and more in the Nursing module, whereas the equivelent error category (Task errors) suggested that this was not a source of difficulty. Problems in carrying out the Task appeared to be detected by the verbal protocols which were not detected by the error information. Indeed the analysis of the verbal protocols which identified the source of difficulty as most often being the 'Text boxes' was in marked contrast to the error information which identified Instructional errors as negligible (Instructions were obtained from Text boxes). The source of the difficulty relating to Text boxes often referred simply to the diminuitive size of the font and in this respect was consistent with the feature 'Screen clarity' which was least preferred throughout the N-CAL package. A finer detail of evaluation resulted from using the verbal protocols to clarify the information obtained from the trace and observer's commentary. Indeed, the error information was found to be misleading in terms of textual instructions, the cause of the difficulty was more appropriately identified only when the verbal protocols were used.

Summary

This experiment continued the evaluation in terms of the structure and process in an attempt to ensure that the components that make up the N-CAL package and its use do not compromise the extent to which subjects can access information from the N-CAL package itself.
An additional evaluation measure was used in this experiment which contributed to the formative evaluation of the N-CAL package, for a more detailed account was available of the users' interaction at the interface of the delivery system of the N-CAL package. The verbal protocols proved to be time consuming to analyse, but valuable information for the development of the N-CAL package both in terms of presentation and content was generated from this measure. Performance measures were found to generate the most useful data which contributed to the development of the N-CAL package. Experiment two provided further evidence of developmental changes required to enhance the ***usability*** of the interface of the N-CAL package. It also provided information which contributed towards the accuracy and relevence of the content of the

N-CAL package.

Whilst the global attitude measure was again encouraging it did not contribute to the development of the package. More benefit may derive from identifying whether the current N-CAL package under evaluation had an effect upon the subjects' attitudes towards N-CAL in general and the third experiment recruited the method of pre- and post-testing to determine this. In addition the observer's commentary dictated that an observer was present througout the experiment with the drawback that subjects were less likely to verbalise their thoughts with an observer close at hand. Since error data was largely obtained from the trace facility and interpreted alongside this measure and the verbal protocol the extent to which the data collected from the observer's commentary contributed to the error information was questionable. The third experiment was used to answer this question by removing the oberver's commentary as a source of evaluation data.

3. Experiment 3

In this experiment subjects were using the learning package as part of the curriculum of a post-registration nursing course in Systematic Nursing (essentially the Nursing Process by another name) which is the specific area of nursing that the N-CAL package addresses. These subjects were chosen for this experiment for their experience was quite different from previous subjects - they saw themselves as learners and they were clearly motivated to gain nursing information from the package.

This experiment, like those discussed previously, was designed as an integral part of the formative evaluation process with the results contributing to the overal development of the N-CAL package. More specifically this experiment was designed to identify whether the subjects (who were seeking to gain nursing information) were able to use the N-CAL package, for this would indicate whether they were able to access the nursing information whilst attempting to comprehend the information presented. Thus, their ability to progress through the Nursing section would be a clear indication of the usability of the package.

Data from this group in relation to their perception of the relative strengths and weaknesses of the WIMP / GUI / HYPERTEXT style of computing would be an indication of their perception of this style of package for gaining access to nursing information.

It was intended that this experiment would explore further the process of evaluation to identify the extent to which measures were capable of providing useful information. It was not clear whether the observer's presence restricted users in verbalising the thoughts driving their actions. Thus, this experiment was designed to answer questions about the measures themselves which had arisen from the previous experiments.

Finally, it was appropriate to identify with this group of subjects, who were themselves learners, whether the N-CAL package under evaluation had engendered any changes in the their attitudes towards N-CAL in general. This would be a better indication of whether they percieved N-CAL to have any value in the spectrum of educational strategies available to them as learners, rather than the educationlists' perception of the value of N-CAL. Thus, this experiment extended the scope of the evaluation to its use as an educational tool as perceived by different users, in this case learners.

3.1. Method

3.1.1. Subjects

Ten qualified nurses all undertaking a Post-Registration Nursing Course to update their knowledge in the area of the Nursing Process were used as subjects. This group of subjects were clearly motivated to gain information about the Nursing Process which was the very information contained within the N-CAL package. The subjects were neither computer-literate nor were they content experts.

The subjects used in this experiment extended the scope of the evaluation closer to the intended end users of this package for they were nurse learners. However, their experiences as qualified nurses would have increased their understanding of the nursing information contained within the package and reduced the cognitive load they would have experienced in using the package and understanding the information it contained. Indeed, they would be able to relate the nursing information contained within the package to their background of experience since the Nursing Process underpins the very practise of nursing.

3.1.2. Apparatus and Materials

The learning package used for this current evaluation was the same as in Experiment two (the Introductory and Intermediate modules of the Tutorial section and the Introductory module of the Nursing section). Eight Apple MacPlus computers with one megabyte of RAM and twenty megabyte hard discs running system 6.0.4 were used with the learning package running under HyperCard version 1.2. Tape recorders were placed in front of the hard disc opposite the subjects

3.1.3. Design of Experiment

The evaluation measures used in this experiment differed in two important respects, one in relation to the formative measures used and the other a measure of outcome. Of the ***formative evaluation*** measures, the observer's commentary was not used in this experiment. Earlier experiments had used the observer's commentrary to disambiguate error data obtained from the trace and had to some extent provided training in the extraction of error data from the trace, for it forced the recognition of errors. Unfortunately the presence of an observer may have interfered with the subjects' ability to provide complete verbal protocols in Experiment two, so by removing the observer in this experiment, the effect that this had on the subjects verbalisations would become clear. Thus, the error data was extracted from the trace and verbal protocols.

A ***measure of outcome*** was used in an attempt to identify any effect generated as a result of using the N-CAL package under evaluation on the subjects attitude towards N-CAL in general. The Attitude towards Computer Assisted Instruction Semantic Differential tool devised and validated by Allen (1986) was used ***prior*** to the subjects using the N-CAL package and ***after*** they had completed the N-CAL package. This was a method recommended by Allen to identify whether the package itself had led to any change in the subjects attitudes.

3.1.4. Procedure

As a group all subjects were given informal instructions on what kind of information they were expected to verbalise whilst using the N-CAL package (the thoughts driving their actions). Prior to using the package on the computer all subjects completed the attitudinal questionnaire individually. Four of the subjects worked in two pairs at the computers. Written instructions and guidance were available at each of the eight computers stating the instructions for using the package and giving concurrent verbal protocols. As in earlier experiments subjects were sat in front of the Apple MacPlus computers at the first screen of the Introductory module and left to continue through the module by following the instructions presented in the package. The trace facility was functional and they were requested to switch on the tape recorder before they started.

On completion of the package the same attitudinal questionnaire was given to subjects and they were asked to rank their feature preference. It is recognised that there may have been some carry-over effect in using the same pre-and post attitudinal questionnaire.

3.2. Results of Experiment three

Again the results will be reported for each of the evaluation measures followed by a preliminary discussion relating the results to the aims and objectives of this experiment (see appendix 1).

Errors

There were a small number of errors in each of the five categories when the error data from the Introductory and Intermediate modules of the Tutorial section were combined (see table 10). Reliable differences were found between the categories of errors and the location of these differences are also recorded in table 10. Instructional errors were least prominant with an error count of zero. The greater proportion of the errors 56%, in the Intermediate module, were associated with two screens, these were two of the screens identified in the previous experiments. No concentration of errors was detected in the Introductory module of the Tutorial section.

There were a small number of errors in each of the five categories for the Introductory Nursing module (see table 10) with reliable differences between the the categories of errors and the location of the differences is also recorded in table 10. Instructional and Task errors were least prominant. No concentration of errors was detected in the Introductory Nursing module.

Time

The average time to complete the two modules of the Tutorial section was 15.8 minutes (standard deviation 4.7 mins.) The correlation between the time taken to complete these modules and the number of errors generated by subjects during the modules (a speed / error trade off) was (Pearson product-moment correlation test, $r=0.31, p>0.05$). The average time taken to complete the Introductory Nursing module was 39 minutes (standard deviation 10.3 mins.). The correlation between the time taken to complete the Nursing module and the number of errors generated by subjects whilst working through this module (a speed / error trade off) was (Pearson product-moment correlation test, $r= -0.27, p>0.05$).

Feature Preference

Across the three judgemental criteria of Useful, Likeable and Memorable there were reliable differences between the subjects' preferences for the thirteen different features (Friedmans' Chi 27.5, 46 and 37.8, $r=10$ and $k=13$, $p<0.05$, see table11).

Wilcoxon's matched-pair signed-rank test was used to identify reliable differences in extreme pairwise comparisons and the results of this test are summarised according to groups of features most and least preferred. Three features (Mouse moving, Mouse pressing and the Absence of the Keyboard) were rated as most preferred across all criteria ($p<0.05$) with the exception of Keyboard Absence for the criterion Memorable ($p>0.05$). Normal Buttons and Screen Clarity were least preferred across the three criteria ($p<0.05$) although Screen Clarity did not feature in the group least preferred for

Table 10. Category of Errors Made - Experiment three.

Introductory and Intermediate Modules of Tutorial Package.

Category	No. Errors	% Errors
Navigation	11	38
Mouse/Button	9	31
Incompletion	6	21
Task	3	10
Instructional	0	0

Note: Friedman's analysis of variance shows Friedman's Chi =12.6, r=8, k=5, $p<0.01$

Wilcoxon matched-pair signed-rank tests shows reliable differences only betwwen Navigation and Instructional errors ($p<0.05$).

Introductory module of Nursing section.

Category	No. Errors	% Errors
Navigation	13	36
Incompletion	12	33
Mouse/Button	9	25
Task	1	3
Instructional	1	3

Note: Friedman's analysis of variance shows Friedman's Chi 17.7, r=8, k=5, $p<0.01$

Wilcoxon matched-pair signed-rank tests shows reliable differences only between either Navigation and Incompletion errors and either Task and Instructional errors ($p<0.05$).

Table 11. Preferences for Delivery System Features - Experiment 3.

The reliability of users' preference differences for package features

Judgemental Criterion	Friedman's Chi	p-value
Useful	27.5	<0.05
Likable	46	<0.05
Memorable	37.8	<0.05

Note: For Friedman's analysis of variance r=10 and k=13.

For these values of r and k the values of Friedman's Chi have been interpreted through extrapolation from critical value tables where k=10. Whilst the p values remain indeterminate it is certainly less than 0.05.

the criterion Useful ($p>0.05$). Figure 3 illustrates the mean values given to the features by all subjects combined across the three judgemental criteria.

Verbal Protocol Analysis

Seven protocols were used in the final analysis of this experiment. One of the verbal protocols was discarded due to the poor clarity of the tape recording which made it impossible to transcribe accurately and four of the remaining nine subjects had worked as two pairs.

A small number of difficulties were identified from the protocols across all modules of the package. A total of twenty six difficulties were expressed by all subjects for the two modules of the Tutorial section and a total of fourteen difficulties were expressed by all subjects for the Introductory Nursing module of the learning package. Using the classification described earlier all were Production difficulties.

A concentration of difficulties was identified on one screen from the Intermediate module (46% of the difficulties for that module), this was one of same screens identified from the error data.

Further analysis of the verbal protocols was discounted due to the small number of difficulties identified.

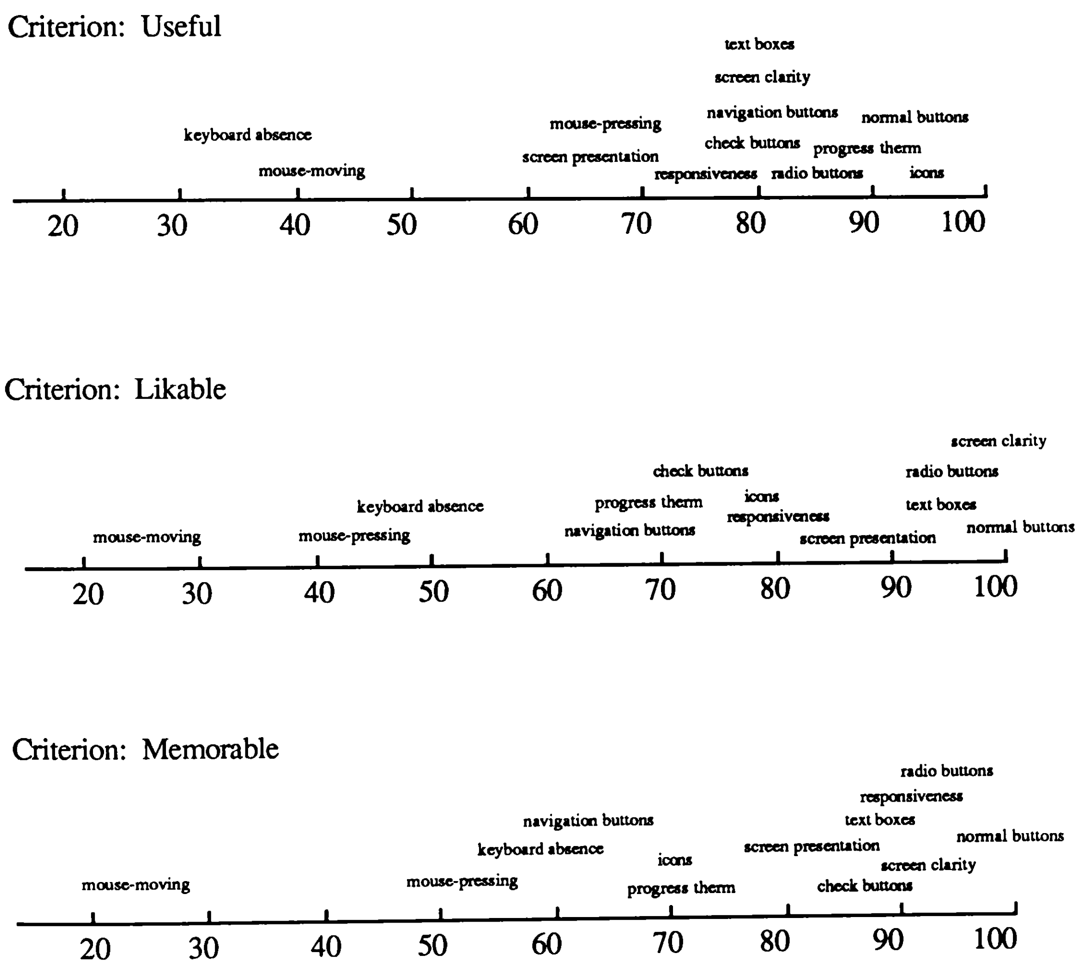
Global Attitudes

A positive change in the subjects attitudes was measured on the post-test when compared to the pre-test using the Attitude towards Computer Assisted Instruction Semantic Differential Tool across all the superordinate functions of Comfort (t-test for related measures, $p=0.0009$, 2-tailed), Creativity ($p=0.0014$, 2-tailed) and Functionality ($p=0.0097$, 2-tailed). However, this result may also reflect some carry-over effect and as such the result must be treated with caution.

3.2.1. Preliminary Discussion

In many respects the results of Experiment three concur with those of Experiments one and two. This preliminary discussion will now relate the results of this experiment with the aims and objectives of this experiment. In common with the other experiments the evaluation measures themselves were under scrutiny but in this experiment the mix of evaluation measures was now being explored. One of the measures (the observer's commentary which had provided useful performance data in earlier experiments) had been excluded in an attempt to identify which measures

Figure 3. Preference Scores for Package Features - Experiment three.



Total score for each package feature for each criterion (lowest score, most preferred).

provided the most comprehensive data.

Were subjects able to complete the N-CAL package ? All subjects completed the Tutorial modules and then proceeded to complete the Nursing module. Attitudes towards N-CAL following exposure to the N-CAL package under evaluation were firmly positive and this is most encouraging from those subjects who were themselves learners. Although this information was not useful to the continued development of this specific package, it was an indication that this style of package engendered posititive reactions.

Were subjects able to complete the individual tasks set within the modules ? This question is particularly important for this group of subjects, for in addition to progressing through the package they were attempting to use the package to access and comprehend the nursing information that the package contained. Within the Intermediate module of the Tutorial section, two of the screens which had generated errors by subjects in the first and second experiments were also the focus of errors in this experiment. The verbal protocols confirmed the error information in one of these screens for it was also found to be a source of difficulty. There was no concentration of errors detected in either the Introductory module of the Tutorial section or the Introductory module of the Nursing section. Indeed from the trace it was identified that the tasks set in relation to the Nursing module were indeed achieved - subjects did access the information in the module in relation to the Nursing Process, subjects did complete the build up of the Nursing Care Plan and subjects did respond appropriately to the questions set within the learning package.

The performance data was again useful by providing hard evidence of the subjects progress through the package and identifying errors and difficulties experienced by subjects. Whilst the observer's commentary had been useful in the first two experiments, it had served its purpose in pointing to the errors which were more objectively identified from the trace. Having focussed the analysis of errors to the trace, over the first two experiments, the trace was used in this third experiment with a degree of confidence that errors were detected having used the first two experiments as training. It was, however, more difficult to assign the errors to a category with any degree of certainty without the data obtained from the observer's commentary.

In the absence of the observer's commentary subjects were more vocal but not always in relation to the thoughts driving their actions. Indeed, in the absence of the observer's commentary (to verify the subject's comments with the perceptual information to which the subject was referring) it was not always clear what information was driving the subject's comment. Indeed this was even more evident in the verbal protocols elicited from the four subjects working in pairs. Whilst these subjects verbalised concurrently it appeared that they also used non-verbal cues to communicate with each other. Thus, the analyses of the protocols from these subjects became difficult to interpret.

The verbal protocols might have been improved by giving subjects practise in providing detailed concurrent commentaries of their actions and this is supported by Ericsson and Simon who reported that subjects require considerable training in this difficult skill before they could provide protocols of value.

How did subjects rate various features of this style of package ? The preference data of the features of a WIMP / HYPERTEXT style of computing supported the data derived from Experiments one and two. The feature Normal Buttons was consistantly rated as a feature least preferred. Little significance is attached to this, however, for Normal Buttons are those buttons with words on them used to initiate definitions or explanations. Indeed, there is often no alternative to using these buttons and perhaps it is because they are a familiar concept frequently used in other areas of education that they are rated as least preferred in comparsison to other more novel features. This finding does suggest that if alternatives to this feature can be used then they should be. The single feature appearing in the group of features most preferred was Mouse Moving. This feature supports a mouse driven package for interaction and provides evidence for raising the profile of this style of package within N-CAL.

Did subjects demonstrate any change in attitudes towards N-CAL in general as a result of having used the package ? A reliably more positive effect was measured towards N-CAL in general as a result of exposure to the N-CAL package under review. Information obtained from this measure is not of specific use to the development of the package but as a measure of outcome it does provide evidence that this style of computing engenders positive attitudes. Even recognising that the result may have been influenced by factors from the use of pre- and post-testing, the result does suggest that this style of computing is worth exploring within nurse education.

Summary

The data from Experiment three contributes to the data obtained from the other two experiments and supports the findings of error concentration in the Intermediate Tutorial module. However, this experiment also progressed the series of experiments. The subjects in this experiment approached the package with a different background of experience and were highly motivated to obtain information from the package. Their reasons for using the package were quite different from the subjects in the previous experiments. In Experiments one and two subjects were participating in an experiment and reviewing the package whereas in Experiment three the subjects were also in a learning role and hoped to gain information from the package. The data obtained from this experiment reflects, to some extent, the intended use of the end product.

The evaluation measures themselves were again under scrutiny. The trace continued to provide an objective performance measure which could be interpreted without the details of the observer's commentary. However, the reason for an error was not always available from the data obtained from the verbal protocols. Indeed if verbal protocols are to be used, then subjects require more than just instructions in giving verbal protocols, they also require practise in providing concurrent verbal protocols to ensure that they verbalise sufficient and appropriate information to enable detailed analysis. Much of the problems in analysing the verbal protocols came in accurately assigning the protocols to the segments, that is, it was not always clear what information the subject was attending to whilst verbalising.

In addition, information was sought in relation to the contribution that the package under review made towards the subjects attitudes towards N-CAL in general. In this respect the data was most encouraging and supportive of pursuing this style of package. Indeed subjects attitudes towards N-CAL in general became more positive following their exposure to this package.

The results of this experiment will now be discussed alongside the other two experiments reported in this chapter. These three experiments represent the formative evaluation of the N-CAL package.

4. Discussion of Experiments One, Two and Three.

The evaluation measures themselves were being scrutinised in these experiments and different measures were seen to be of value dependant upon the stage of the development / evaluation cycle. Early in the construction of the N-CAL package, measures which pointed to the preferred style of interaction provided a useful indication for the design of later modules in the package still under construction. As the package developed more specific measures were recruited to extract information in relation to errors and difficulties and finally towards the end of the development it was appropriate to measure whether the package contributed towards the subjects view of N-CAL in general.

During formative evaluation user performance measures generate hard evidence of developmental changes required to improve the usability of the package. User performance measures were extracted from three different measures in this series of experiments:

i) the trace provided an objective recording of the user's human-computer interaction,

ii) the observer's commentary sought information of the user's observable behaviour and

iii) the verbal protocols sought information in relation to the user's thoughts behind their actions.

All of these performance measures were time consuming in their own way - the trace required additional programming and training in the extraction of data from it, the observer's commentary was time consuming to collect, for it required an observer to be present for each subject whilst they used the package and the verbal protocols were time consuming to analyse. However, the data generated from performance measures was of much greater value to the development of the package than data derived from global attitudes. Global attitudes are apparently easy to collect but of little or no use during the formative evaluation process of an N-CAL package. However, attitudes in relation to specific features of the computing style used in this N-CAL package were reliably generated from the subjects and was a useful formative evaluator.

The experiments reported in this chapter were primarily designed to elicit data in relation to the structures and processes of this style of computing and to a lesser extent measures of outcome were sought. The discussion will now focuss on the data obtained in relation to each of the component parts of Donnabedian's framework for evaluation.

Structures

Data was obtained from different subject / users in the three experiments progressively widening the scope of the evaluation and as a result the focus of the evaluation varied slightly over the three experiments commensurate with the subjects background and expertise. ***The experiments reported thus far were instrumental in identifying those features of computing which should receive a higher profile within N-CAL.*** The structural features which were identified as being most preferred were interactive screens using a mouse driven interface. Screens where the nursing content of the package was insufficient or inappropriate were identified and easily rectified. Formal data was obtained from educationlists and nurse learners thus, different users of an N-CAL package were used to provide feedback during the development of the package. In addition, but no less important, the programmer / author of the N-CAL package (an educationalist with little formal programming skills) was able to adjust the package with little effort in a short space of time based upon feedback from the formative evaluations.

Processes

The processes under evaluation referred to the interaction of the structures, that is the interaction at the interface of the hardware, software and user. It is perhaps easier to think of the process as the usability of the N-CAL package by the user. Data from a total of forty subjects provided statistically significant evidence for a number of developmental changes. ***Specific changes which are likely to improve the usability of the N-CAL package under construction were identified from this series of experiments.***

Outcome

The measure of attitude towards N-CAL using an established questionnaire was the only immediately recognisable measure of outcome used in the final experiment. The N-CAL package under development was seen to engender positive attitudes towards N-CAL in general. However, an equally valid measure of outcome was used throughout the series of experiment in the completion of tasks determined from user's visible behaviour (observer's commentry), the interaction response protocol (trace) and verbal protocols. Where tasks were not completed Incompletion or Task errors were identified from the trace and observer's commentry and production difficulties were identified from the verbal protocols. Whilst this information was primarily a measure of process, for it measured user performance, it also provided a measure of outcome, for the tasks themselves relate closely to the objectives and provide the detail of how the objectives are achieved.

In the Tutorial section, for example, to achieve the second objective listed in chapter 3 (users will have demonstrated moving the cursor over screen buttons) specific tasks on a number of screens were designed to introduce users to this and then let them practise. The task set on one of the screens in the Introductory module of the Tutorial section required users to move the pointer into each of the four corners of the screen by moving the mouse on the desk top and each corner of the screen higlighted as they did this. Thus, the completion of the specific task in this instance was demonstrated by highlighting the four corners of the screen. On a different screen the task was to initiate actions of different buttons on the screen - by moving the screen pointer over the button presented on the screen called 'date' and by clicking the mechanical button on top of the mouse the current date became visible on the screen. Thus, objective two of the Tutorial section (described earlier) and objective three (the user will have intiated actions associated with screen buttons) was partially addressed by this task. A further task on one of the final screens in the Tutorial section was presented as a game. Users were required to dehighlight ten different buttons overlaying small pictures distributed around the screen by moving the screen pointer over the pictures, which highlighted in a random order, and pressing the mechanical button on top of the mouse. Users' response times were displayed after they had successfully dehighlighted the ten different buttons. For users to have reached this final screen they must have progressed through the modules by using navigation icons (forward and backward pointing arrows). Thus, they had succesfully demonstrated the completion of several tasks on the way through and in completing the game they also demonstrated achieving the two goals of the Tutorial section (1. users will be able to utilise information presented in textual, iconic and graphic forms, 2. users will have used the mouse button system rather than the QWERTY keyboard to interact with the package). Thus, tasks provide the fine details through which the objectives are achieved and ultimately the completion of the diversity and number of tasks provide a measure of outcome relating to the achievement of the goals.

In the Introductory Nursing module there was a great number of tasks relating to the objectives. For example, in respect of the first objective, (the user will have accessed information presented in the module in relation to the Nursing Process) the details of the Nursing Process was presented over twenty different screens with users accessing the details by clicking over text buttons or Hypertext for definitions. Incompletion errors were identified at one particular screen where the information was felt to be crucial to user's understanding of the information and a decision was made to limit user's ability to move on without having accessed the detail of information at this screen. In respect of the second objective, (users will have completed the build up of a Nursing Care Plan demonstrated in the module) a Nursing Care Plan was built up over three different screens and it was easy to identify whether the Care Plan was completed, indeed all subjects completed these tasks. Finally, in respect of the third objective (users will have responded appropriately to the questions set within the module) the user's response to the eleven multiple choice questions was recorded by the interaction response protocol and the verbal protocols. Only one of these questions resulted in errors or production difficulties and seven subjects in experiment two commented that the nursing information content was inappropriate. Thus, the reason for the error was attributed to ambiguous wording in the answers as a result of the analysis from the verbal protocols.

Evaluation measures primarily used for the identification of process components or interaction have also been used succesfully as a measure of outcome. ***User performance measures have provided objective data and hard evidence of developmental changes required to improve the usability of the package but, in addition, they have also been used to make some statement about the package in relation to the individual tasks which provide the detail of how the objectives and ultimately the goals are achieved.*** Hewett (1986) has suggested that the methods used for formative and summative evaluation are the same, the only difference lies in how the data is used and Alexander (1983) recognised a similar blurring of the edges between formative and summative evaluation within evaluation studies carried out in the field of nurse education. Whilst this is demonstrated with user performance measures this observation did not, however, apply to global attitude measures for they provided no evidence of developmental changes required.

The N-CAL package now needed to be evaluated under the conditions normally imposed within nurse education. The next chapter reports two experiments when the N-CAL package was integrated into a curriculum for Pre-Registered Nurse Education. Nurse learners' attitudes, specifically directed towards their opinions of this computing style, will be the focus of the evaluation reported in the next chapter.

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Chapter 5

COMPARATIVE EVALUATION OF COMPUTING STYLES BASED ON USER ATTITUDES AND OPINIONS

Introduction

The experiments reported in this chapter were designed to compare the WIMP / GUI / HYPERTEXT style of computing with the traditional style of computing utilised within Colleges of Nursing represented by the Acorn BBC microcomputer QWERTY / textual interface. The previous experiments had identified that subjects were able to reliably rate different features of the WIMP / GUI / HYPERTEXT style of computing, and these features were used to compare this style of computing with the more conventional style of computing utilised within nurse education and currently integrated within a curriculum of nurse education.
The N-CAL package developed to accommodate the evaluations of this project, described in Chapter three, was designed to be used by nursing students as part of the pre-registered nurse education curriculum. The N-CAL package was now going to be used alongside a traditional N-CAL package in a busy nursing curriculum and a comparison of the two different computing styles would be the focus of the evaluation exercise. There were inevitably restrictions imposed by the integration of this experiment within a nursing curriculum in terms of time, number of subjects and the availability of equipment. For example, the time allocated in the students curriculum was insufficient to include detailed performance evaluation measures of the type used earlier. The number of computers available restricted computer-use within the curriculum to a group activity. Even the environment within which the experiments took place was less than suitable for the available space was restricted. As a result the evaluation methods developed earlier were revised to accommodate these restrictions. The use of the N-CAL package, in these less than ideal circumstances, was, however, representative of how the package, developed in this project, might be used in a curriculum by nurse learners and as such this represented an opportunity to evaluate the package in the "real world" of nurse education.

This evaluation exercise is, perhaps, more readily associated with summative evaluation for it attempts to make some statement about the end product of the development stage. Indeed the information sought here is not expected to contribute to the development of the N-CAL package in any constructive way.

Two experiments are reported in this chapter: Experiment five was designed to answers questions raised from the results of the Experiment four.

1. Experiment Four

This experiment was designed to evaluate and compare two different styles of computing through a comparison of the delivery systems of i) the Acorn BBC using a Microtext N-CAL package representing the traditional approach to N-CAL and ii) the Apple MacPlus using a HyperCard N-CAL package representing the more contemporary approach to N-CAL. No attempt was made to make the nursing content of each package identical but the information contained within the two packages covered a similar area (the Nursing Process) and both packages were appropriate for the students' current stage in the nursing curriculum.
This experiment sought to compare student nurses' opinions in terms of specific features of the different computing styles. Rather than use global attitude measures, their opinions were directed towards simple features of the computing styles, which earlier experiments had demonstrated that users could discriminate.

1.1. Method Used in Experiment Four

1.1.1. Apparatus and Materials

Two N-CAL packages were used, 'Nursing Assessment' (McCormac et al 1990) which had been integrated into the curriculum of the South College of Nursing, Glasgow for a period of eighteen months and the Introductory and Intermediate modules of the Tutorial section followed by the Introductory module of the Nursing section of the N-CAL package, designed in this project, also integrated into the curriculum of Pre-Registered Nurse Education for the purpose of this experiment. A total of twenty computers were utilised - ten Acorn BBC master series running Microtext version 2.0 under which the former package ran and ten Apple Macplus's running system 6.0.4. and Hypercard version 1.2 under which the latter package ran.

Two assistants were recruited to collect data from half the subjects.

1.1.2.Subjects

A new intake of 69 students nurses in the second week of their Pre-Registered Nurse Education were recruited as subjects from the South College of Nursing, Glasgow and the evaluation exercise was scheduled within the students' timetable. Subjects worked in groups of three or four and an individual in each group was identified as being the operator of the computer and the remaining members of the group observed. The operators were the only subjects to have hands-on experience of using the computers during the experiment, (operators, n=20 and observers, n=49). Operators used the keyboard on the BBC and the Mouse / Button system on the MacPlus. Both the operators and the observers viewed the screen and the observers contributed to the decisions the operators implemented.

1.1.3. Design

As part of computer orientation within the nursing curriculum the subjects had been exposed to a two hour introduction to the use of computers in nursing on the day prior to the experiment and they had used the Acorn BBC to learn some computing skills. This experience was unsatisfactorily outwith the control of the experimenter.

The opinions of the student nurses were the only evaluation measure utilised. Subject's opinions of ten different features for each computing style, represented by the two N-CAL packages, were collected. Subjects were asked to rate the ten features of the respective computing style on a 7-point scale in terms of i) how they “liked” the features and ii) the contribution that the features made towards “ease of use” (see appendix 2). These features represented eight functionally equivalent pairs, for example, the main user-input device on the MacPlus was the mouse-driven screen-pointer which was used to activate screen buttons, on the BBC the main user-input device was the keyboard and termination of the information was activated by pressing the ‘return’ key (see figure 4 for a description of the remaining seven pairs of functional features for the two N-CAL packages). Whilst completing the questionnaires subjects were asked to concentrate on the features of the computing styles contributing or otherwise to the delivery of the nursing information and not on the nursing information itself. This point was continually stressed during the experiment.

Figure 4. Functionally-equivalent pairs of the eight computer-use features comprising the two N-CAL packages.

MACPLUS	FUNCTIONAL FEATURE	BBC
Mouse-driven screen-pointer activating click-sensitive screen buttons.	MAIN USER-INPUT DEVICE	Keyboard with 'return' termination
Mouse/pointer used to select and record choice through clicking check-buttons on the menu.	INPUTTING AND RECORDING DECISIONS FROM MULTIPLE-CHOICE MENUS	Typing in code from menu (and 'return') to select and record choice.
Mouse/pointer used to select a word and retrieve information about it.	WORD QUERIES	Typing in a word and selecting it with 'return' to retrieve information about it.
Users controlling the direction and pace through the package using icons.	PACKAGE NAVIGATION	Users controlling the direction and pace through the package by following textual instructions.
Ever-present on-screen visualisations of information to help control direction and pace through the package.	NAVIGATION INFORMATION	Use of function keys to make visible information to help control the direction and pace through the package.
Highlighting key words with text of different fonts, sizes and styles.	WORD EMPHASIS	Highlighting key words with coloured text.
Detailed picture as the main non-textual information.	ILLUSTRATIVE GRAPHICS	'Chunky' graphical representations as the main non-textual information
Shaded and patterned backgrounds as the main method of varying presentations.	SCREEN BACKGROUNDS	Coloured backgrounds as the main method of varying presentations.

A three-factor mixed design was utilised in which all subjects were exposed to both computing styles (the N-CAL package on the BBC and the N-CAL package on the MacPlus). The three factor mixed design is formally described as:
Factor 1 was related at 2 levels: Level 1 the MacPlus and Level 2 the BBC.
Factor 2 was independent at 2 levels: Level 1 was the group MB who had used the MacPlus first and Level 2 the group BM who had used the BBC first.
Factor 3 was independent at 2 levels: Level 1 was the operators and Level 2 the observers.
The subjects were divided into two groups, all subjects used both computers but in a different order and the subjects at any one computer were assigned to one operator who worked the machine whilst the remaining subjects at that computer observed. The operators and observers maintained these roles throughout the experiment.

1.1.4. Procedure

Subjects were allowed 45 minutes to complete the N-CAL package of the respective computer. After completing the first N-CAL package they were given the two questionnaires on which they were asked to rate the ten features of the computing style that they had just been exposed to. Subjects then used the N-CAL package on the second computer after which they completed two similar questionnaires rating the ten features of the second computing style according to "like" and "ease of use". When completing the questionnaires of the second computer style they had for reference the ratings they had assigned to the first computer.

1.2. Results of Experiment Four

A Mixed Design Analysis of Variance (Kirk 1968) was carried out on the data combined and separately for both 'like' and 'ease of use'.

Factor 1: Computing Style

The overall rating scores across the ten different features of the questionnaires for "like" and "ease of use" for each computing style were combined for each subject ($n=69$). The BBC was rated reliably higher than the Mac (BBC mean score 116.92 and Mac mean score 104.8, Main effect Factor 1 $p<0.0001$). For both "like" and "ease of use" seperately the BBC was also rated reliably higher than the Mac ("like" ratings: Mac mean score was 52.0, the BBC mean score was 59.5 and "ease of use" ratings: Mac mean score was 52.1, and the BBC mean score was 58.2, $p<0.0001$ for both measures).

Factor 2: Order of Use

There was a reliable difference between the two groups. The group using the Mac first rated the two computers reliably higher than the group using the Mac second (Group MB mean score 119.32 and Group BM mean score 102.5, Main effect Factor 2 $p<0.0006$) and for both "like" and "ease of use" a similar picture emerges ("like" ratings: Group MB mean score 60.49 and Group BM mean score 51.02, and "ease of use" ratings: Group MB mean score 58.4 and Group BM mean score 51.88, $p<0.0006$ for both measures).

Factor 3: Role at the Computer

There was no reliable difference detected between the subjects role (operators mean score 112.31 and observers mean score 110.4, Main effect factor 3 $p>0.44$) and similarly there was no reliable difference between the ratings allocated by the subjects role for both "like" and "ease of use" ("like" ratings: operators mean score 56.68 and observers mean score 54.84, $p=0.44$ and "ease of use" ratings: operators mean score 54.93 and observers mean score 55.35, $p=0.81$).

Interaction Effects

The three way interaction was unreliable ($p>0.39$). However, three way interactions are notoriously difficult to interpret and much more can be gained from reporting each of the two way interactions.

Factor 1 (computing style) X Factor 2 (order of use)

The results revealed a reliable interaction effect between the ratings allocated to the computing styles by the two groups dependant upon the order in which they had use the computers ($f=20.3$; $df=1,65$; $p<0.0001$ Anova Factor 1 and 2 interaction), figure 8.1 graphs this effect for both "like" and "ease of use" data seperately. The mean scores for "like" data were: Group MB at the Mac 60.3 and at the BBC 60.68, Group BM at the Mac 43.72 and at the BBC 58 .32. Mean scores for "ease of use" data were: Group MB at the Mac 58.19 and at the BBC 58.6, Group BM at the Mac 46.06 and at the BBC 57.7. A reliable reduction in the rating of the Mac by the group BM, who has

used the BBC first, was found (test for simple effects $p<0.0001$) and a reliable difference was detected between the ratings allocated to the two computing styles by the Group BM (test for simple effects $p<0.0001$). The Group MB, however, rated both computing styles as equivelent (test for simple effects $p>0.79$) and rated the BBC equivelent to other groups rating of the BBC (test for simple effects $p>0.4$)
The rating of the Mac by the group BM using the BBC first was quite different to their rating of the BBC and was also quite different to the other group's rating of the Mac. Further analysis of the "like" and "ease of use" data seperately revealed the same results described above and these results are graphed in figure 5. Analysis of the individual feature pairs was carried out to identify which contributed most to this result. This result was reliably replicated across all feature pairs for the "like" data and more than 50% of the "ease of use" data (Anova Factor 1 and Factor 2 interaction $p<0.05$; test for simple effects $p<0.05$).

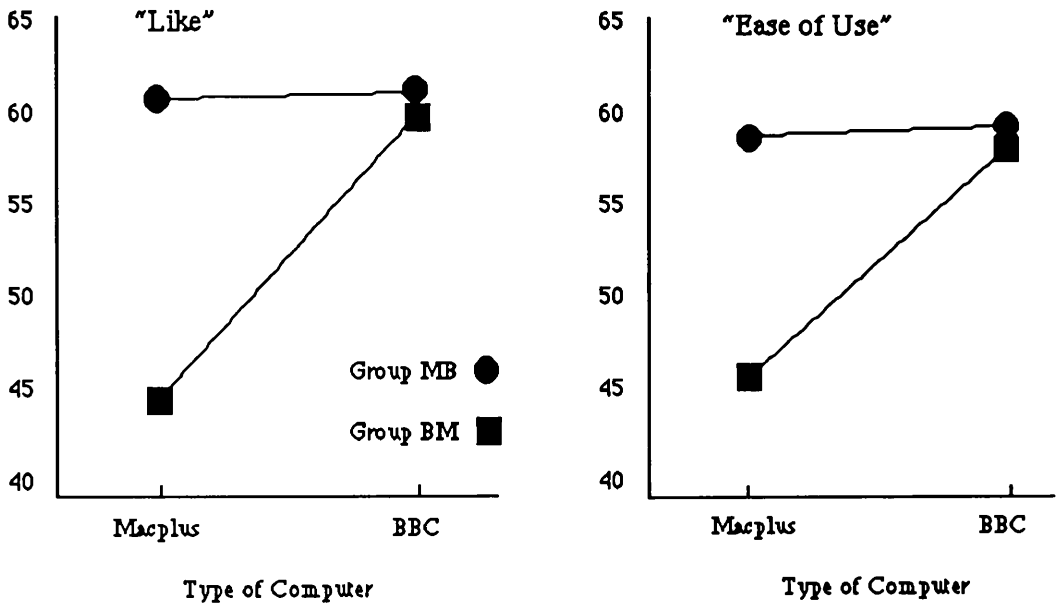
Factor 1 (computing style) X Factor 3 (role at the computer)

There was no reliable interaction effect for "ease of use" data between the subjects role at the computer and computing style ($f=1.03$; $df=1,65$; $p=0.32$, Anova Factor 1 and 3 interaction) but there was a reliable interaction effect between the subjects role at the compter and computing style for "like" data ($f=4.03$; $df=1,65$; $p=0.49$, Anova Factor 1 and 3 interaction), figure 6 graphs this result. The mean values for the "like" data were: the operators at the Mac 54.5 and at the BBC 58.85, the observers at the Mac 49.52 and at the BBC 60.16. A reliable difference was detected between the scores allocated by the observers over the two different computing styles (test for simple effects $p<0.0001$) whereas the operators scored both computing styles as equivelent (test for simple effects $p=0.11$). There was no difference in the ratings by either groups at the Mac (test for simple effects $p=0.08$) or at the BBC (test for simple effects $p=0.65$). This result was reliably replicated across all the feature pairs for "like" data. The interaction effect was identified as a function of the observers reliably lower rating of the Mac in comparison to their rating of the BBC.

Factor 2 (order of use) X Factor 3 (role at the computer)

There was no reliable interaction effect between the order of use and the subjects role at the computer ($f=1.8$; $df=1,65$; $p>0.15$, Anova Factor 2 and 3 interaction). No further analysis of this will be reported.

Figure 5. The combined "like" and "ease of use" rating scores for each computer in Experiment four.



Test for Simple Effects identified that the group BM's ratings were reliably different for the two computing styles ($p<0.0001$) and their rating of the Macplus was reliably lower than their rating of the BBC ($p<0.0001$). There was, however, no reliable difference between the rating given to the BBC by the two groups, nor was there a reliable difference in the group MB's ratings of the two different computing styles.

Mean scores "like" data:
Group MB at the Mac 60.3 and at the BBC 60.68
Group BM at the Mac 43.72 and at the BBC 58 .32

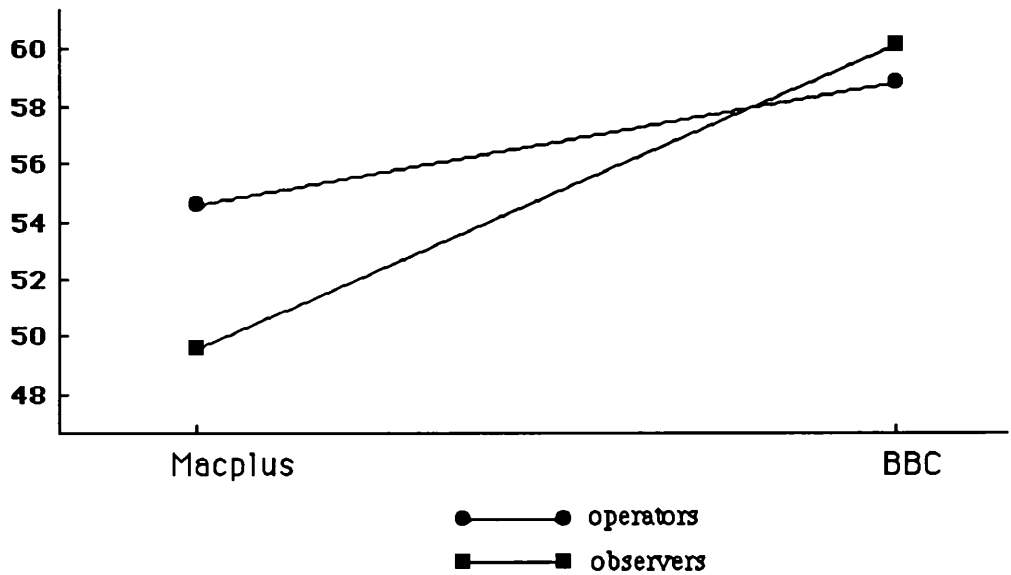
Mean scores "ease of use" data:
Group MB at the Mac 58.19 and at the BBC 58.6
Group BM at the Mac 46.06 and at the BBC 57.7

1.2.1. Preliminary Discussion of Results

The observers rated the two computing styles for "like" data quite different (see fig.6). The observers mean score for the BBC was higher than their mean score for the MacPlus whereas the operators did not demonstrate any difference in their opinions of the two computing styles. This result might reflect subjects responding to the content of the different N-CAL packages rather than the style of delivery of the packages. The BBC programme was liked more by the observers and it involved more group discussion. The content of the MacPlus package was more individually orientated engendering less positive responses by those less involved. The operators involvement was the same over the two computers and they showed no preference for either computer.

The overall preference for the traditional style of computing represented by the BBC with the Microtext programme over that represented by the MacPlus and HyperCard is surprising for the shortcomings of this style of computing is clear to most experienced users. The reliable preference for the BBC was, however, almost entirely due to the measures taken when the MacPlus was used as the second computer for there was no sign of preference when the MacPlus was used first. One possible explanation is that the group using the BBC first became familiar with the style of computing and as a result when exposed to the MacPlus rated it poorly by comparison. This would support a phenomenon identified by Brooks and Johnston (1990) suggesting that users' attitudes in their study might have been formed by utility change (unfamiliarity) rather than the change in utilities themselves. However, this would not explain why those using the MacPlus first did not demonstrate a negative preference for the BBC after becoming familiar with the MacPlus unless, the computer orientation that the subjects had been exposed to the day previous to the experiment was sufficient to offset the Mac to BBC contrast experienced by the group who had used the Mac first. The effects of a prolonged exposure to the BBC compared to the considerably shorter introduction to the MacPlus may have been the cause of the anomaly. If, however, this were the only factor why then did the group using the Macplus first not demonstrate a negative preference for the Macplus using their pre-exposure as a contrast? The answer must surely be that users were not simply responding to 'change' but more likely to the distribution of their total exposure to the two different computing styles. For example, it is claimed by those who commercially train nurses in computer-use skills that the development of such skills is best done in relation to

Figure 6. Combined "like" data for all features, operators and observers - Experiment four.



Test for Simple Effects identified a reliable difference in the ratings allocated to the two computing styles by the observers ($p<0.0001$) but the operators did not demonstrate a reliable preference for either computing style ($p=0.11$).

Mean values for "like" data:
operators at the Mac 54.5 and at the BBC 58.85
observers at the Mac 49.52 and at the BBC 60.16.

tasks which are orientated to their working environment (Von Grey 1991). Subjects in this experiment expected to learn about nursing thus the application of the computer-use skills to learn about the Nursing Process orientated the task of learning computer-use skills to a purpose of particular relevance to them. Clearly developing computer-use skills extends beyond the sessions for the Macplus labelled Tutorial section. Computing skills developed further when using the Nursing section and users became more familiar with these skills the more they were used. Similarly users' computing skills of the BBC were developing when they used the Nursing Assessment package.

The group using the Macplus second had been exposed to extensive training in the use of the BBC through their pre-exposure and their use of these skill to learn about the Nursing Process and as a result rated the Macplus low, whereas the group using the Macplus first had not had the lengthy exposure to the BBC when they rated the Macplus and gave it an equivalent rating to the BBC package. The anomaly lay in the group using the Macplus last rating that computer low.

Whilst questions of reliability of the data were empirically tested with the ANOVA, there was some doubt about the validity of the measures taken from subjects, for it was unsatisfactory that the computer orientation that the subjects had been exposed to the day previous to the experiment was outwith the control of the experimenter. Subjects had been introduced to the Acorn BBC computer-use during a two hour session and in contrast, the introduction to the MacPlus computer-use was incorporated within the one hour session prior to using the Nursing Process N-CAL package.

The results of Experiment four suggest that pre-exposure may have affected the subjects attitudes and opinions, but no firm conclusions could be reached on the basis of the results reported in this experiment. However, the value of learners' opinions as a valid evaluation measure would be questionable if this were the case, with considerable implications for the evaluation of N-CAL which relies heavily on measuring attitudes and opinions from users. Thus, Experiment five was designed to investigate the hypothesis that pre-exposure effects learners subsequent attitudes. The criticisms which question the validity of the results of this experiment will be handled by re-designing the next experiment to control the pre-exposure to computing styles.

2. Experiment Five

The current experiment was designed to investigate whether subjects pre-exposure to a computing style effects their subsequent opinions of a different computing style. This experiment will be contrasted with the results of experiment four. It is an important point to note that, unlike Experiment four, it is not the opinions themselves but rather the ***process of opinion formation*** which is the focus of this evaluation exercise, for evaluations such as this, based on opinions, have been used widely by nurse education. If, indeed, it is the case that opinions are formed as a result of extraneous variables, as the results of Experiment four suggested, then their use as valid evaluation measures would be seriously in doubt.

2.1. Method

The apparatus and materials used in Experiment five was identical to that used in Experiment four. The packages were again integrated into the curriculum in the second week of Pre-Registered Nurse Education. Subjects (n=60) from a subsequent new intake of student nurses at the South College of Nursing, Glasgow were used.

2.1.1. Design

The design of Experiment five was wholly symmetrical in an attempt to reduce the differential exposure to the two computing styles and determine whether the results identified in Experiment four were indeed the result of pre-exposure. To accommodate this subjects were not exposed to any computer-orientation outside the control of the experimenter.

The experiment now ran over two days - the first day was a computer training day where subjects were introduced to the computer-use skills for the MacPlus and the BBC. The second day was the nurse training day when the subjects applied the computer-use skills that they had picked up from the previous day to learn about the Nursing Process using Nursing Assessment on the BBC and the Introductory Nursing module on the MacPlus (that is the identical packages used in the previous experiment).

The same three factor mixed design, as in experiment four, was used. All subjects experienced both computing styles. The group identities (MB using the MacPlus first, BM using the BBC first) were retained over to the second day. The subjects at each computer were again assigned to roles, one operator used the QWERTY keyboard on the BBC and the Mouse / Button system on the MacPlus, the remaining subjects observed. All subjects viewed the screen and contributed to the decisions but only the operator implemented those decisions through the input devices of the respective computers.

The questionnaires used in Experiment five were identical to Experiment four. Subjects completed the questionnaires on the second day immediately after using each of the two different N-CAL packages on the computers on the nurse training day. In all other respects Experiment five was identical to Experiment four.

2.2. Results

The combined data was analysed using a 3 Factor Mixed Design Analysis of Variance (Kirk 1968) and then analysed seperately for both "like" and "ease of use" data.

Factor 1: Computing Style

The combined rating scores of the ten different features of the questionnaires for each computer N-CAL package and all subjects (n=60) for both "like" and "ease of use" identified that the BBC was rated reliably higher than the Macplus by a small margin (BBC mean score 115.79 and the Macplus mean score was 112.83, Main effect Factor 1, p=0.045). There was a reliable difference in the ratings allocated by subjects for the "ease of use " data (BBC mean score 59.79 and Mac mean score 55.81, p= 0.025) but there was no reliable difference detected for the "like" data (BBC mean score 58.59 and Mac mean score 54.91, p= 0.12).

Factor 2: Order of Use

There was no reliable difference between the ratings allocated by the two groups (Group MB mean score 110.52 and Group BM mean score 118.1, Main effect Factor 2 p=0.45). Similarly for both "like" and "ease of use" data there was no reliable difference between the groups ("like" ratings: Group MB mean score 54.63 and Group BM mean score 58.59, p=0.07 and "ease of use" ratings: Group MB mean score 58.18 and Group BM mean score 57.42, p= 0.71).

Factor 3: Role at the Computer

There was no overall reliable difference detected between the subjects role at the different computing styles (operators mean score 113.5 and observers mean score

115.12, Main effect Factor 3 p=0.68). Nor was there a reliable difference for either "like" or "ease of use" data ("like" ratings: operators mean score 57.36 and observers mean score 55.86 and "ease of use" ratings: operators mean score 57.96 and observers mean score 57.64, p> 0.5 for both measures).

Interaction effects

The three way interaction was unreliable (p=0.3). In keeping with the previous results the interaction effects are more easily intrepreted as three two way interactions.

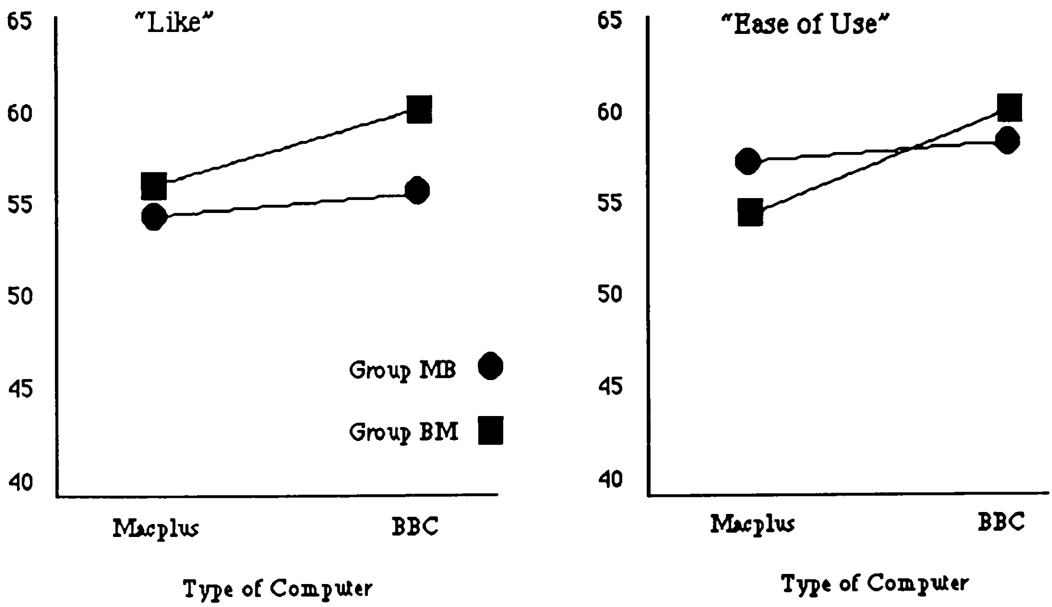
Factor 1 (computing style) X Factor 2 (order of use)

There was no reliable interaction effect between the ratings allocated to the two computing styles by either of the groups (f=1.52; df=1,56; p=0.22, Anova Factor 1 and 2 interaction). The same result was replicated across the "like" and "ease of use" data ("like" ratings: mean scores by the Group MB at the Mac 53.8 and at the BBC 55.46, Group BM at the Mac 56.02 and at the BBC 61.17; "ease of use" ratings: mean scores by the Group MB at the Mac 57.49 and at the BBC 58.86, Group BM at the Mac 54.13 and at the BBC 60.72). Figure 7 graphs this result demonstraing that the two groups rated the two computing styles as comparable. No further analysis was carried out.

Factor 1 (computing style) X Factor 3 (role at the computer)

There was no reliable interaction effect between the subjects role at the computer and their ratings of computing styles (f=0.44; df=1,56; p=0.51, Anova Factor 1 and 3 interaction). Nor was there a reliable effect demonstrated for either the "like" or the "ease of use" data ("like" ratings: mean scores allocated by the operators at the MacPlus 54.57 and at the BBC 57.14, the observers at the MacPlus 55.24 and at the BBC 59.48; "ease of use" ratings: mean scores allocated by the operators at the MacPlus 56.36 and at the BBC 58.93, the observers at the MacPlus 55.26 and at the BBC 60.65). Figure 8 illustrates a reliable difference detected between the ratings allocated to the two different computing styles by the observers (p=0.007, test for simple effects). There was no reliable difference detected between the ratings allocated by the operators (p=0.43, test for simple effects) nor was there a reliable difference between the ratings allocated at either the MacPlus or the BBC (p>0.36 for both measures, test for simple effects).

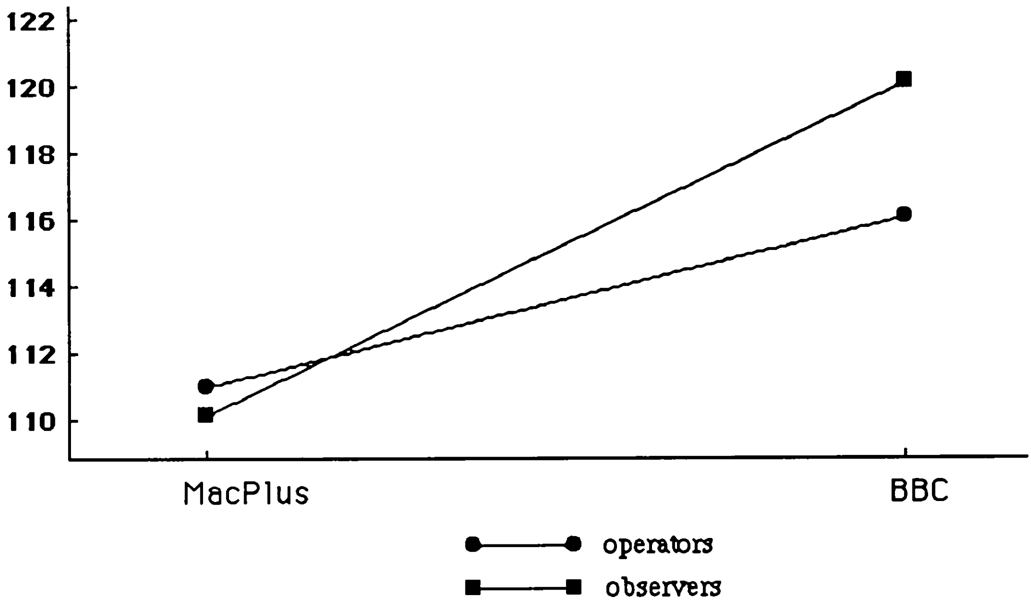
Figure 7. The combined "like" and "ease of use" rating scores for each computer in Experiment five.



The groups BM and MB rated both the Macplus and the BBC in the same way in Experiment five.

In contrast to figure 5. , it is clearly demonstrated that the reliable results reported for Experiment four have disappeared in Experiment five.

Figure 8. Combined "like" and "ease of use" data for all features, operators and observers - Experiment five.



Analysis of simple effects: the observers rated the Macplus reliably lower than the BBC (p=0.007), whilst the operators did not demonstrate a preference for either computing style (p=0.43).

Mean Values:
operators at the Mac 110.93 and at the BBC 116.07
observers at the Mac 110.11 and at the BBC 120.13

Factor 2(order of use) X Factor 3 (role at the computer)

There was no reliable interaction effect between the order of use and the subjects role (f<0.0001; df=1,56; p=1.0, Anova Factor 2 and 3 interaction). Further analysis was not carried out.

2.1 Preliminary Discussion of Results

Whilst there was no overall differences identified between the subjects roles at the computer there was a reliable difference detected between the ratings allocated to the two computing styles by the observers and no such difference was detected in the ratings allocated by the operators (see fig. 8).

The results of Experiment five did not detect any difference in the ratings scores allocated by the two groups dependant upon the order in which the computing styles were used (see fig. 7).

Subjects continued to have a small overall preference for the BBC style of computing, but only in respect of the "ease of use" data, for there was no preference demonstrated by subjects according to the "like" data. This result is surprising for the advantages offered by the more contemporary style of computing available from the MacPlus does not appear to have impacted this group of users.

What then could possibly account for this result, is it as straight forward as it appears? There is more to be gained from a discussion of the two experiments and possible explanations may emerge.

3. Discussion of Experiments Four and Five

It is the practise within nurse education for computer-use within the curriculum to be a group activity, but the experience of the learners within the group may differ, for over both experiments the opinions generated by the operators in relation to the different computers differed to that of the observers. The observers preferred the BBC and demonstrated a negative preference of the MacPlus, whereas the operators were equivocal in the preference.

One possible explanation for the overall preference reported for the BBC in these experiment, may be explained by the MacPlus having suffered throughout the developmental evaluations to individual subjects reporting poor screen clarity.

Intuitively, one would expect this feature to have a greater adverse effect on computer-use when the computer is used by a group. Forty two general comments received from the subjects in the final experiment were in relation to the screens of the different computers, either screen size (the MacPlus was too small or they preferred the larger screen size of the BBC) or the use of colour (the MacPlus was a monochrome screen whilst the BBC was colour which the subjects preferred). In addition a small number of subjects complained of tired or strained eyes as a result of using the MacPlus, whilst no similar complaints were made in relation to the BBC. This may have contributed to a poorer rating of the MacPlus but other explanations might have had greater impact upon users opinions.

The result, reported in Experiment four, demonstrating a reliable difference between the two groups dependent upon the order in which the subjects used the computers disappeared in Experiment five for both "like" and "ease of use". Figures 5 and 7 clearly shows the marked contrast between the two experiments. The only important aspect in which Experiment five differed from Experiment four was that in Experiment five the amount of pre-exposure to either the BBC or the MacPlus was carefully controlled by the experimenter in the immediate period prior to using either computer to learn about nursing related information and complete the questionnaires on the subjects' preferred computing style. The differential exposure to the BBC which was apparent in Experiment four was reduced in Experiment five, for both groups were exposed to training in computer-use skills on the MacPlus and the BBC which was as equivelent as possible before completing the questionnaires in Experiment five.
It is concluded that the negative preference reported for the MacPlus in Experiment four was a result of the subjects pre-exposure to the BBC in the extensive training in the use of the BBC the day prior to Experiment four. This experiment shows that there is a high probability that subjects will respond negatively to a change in computer-use when opinions are sought in relation to the actual use of a computer. The overall preference for the BBC was seen to be considerably reduced when pre-exposure was controlled in the immediate period leading up to Experiment five, but an overall preference for the BBC still remained. A more robust explanation has become apparent for, clearly, pre-exposure to the BBC could not have been entirely controlled. Most subjects were exposed to the BBC (and some extensively) at school. If, as this Experiment shows, subjects respond negatively to a change of computer-use then the results of prolonged exposure to the BBC at school is likely to have affected

their opinions of the MacPlus computer-use and the rating of the MacPlus is likely to be an underestimate. In support of this Bitzer and Boudreaux (1969) showed that students' attitudes to a particular N-CAL presentation became more positive with increased exposure.

Summary

Even when nurse learners opinions were directed towards simple feature pairs used in the questionnaires, their opinions were seen to be influenced by factors not entirely within the control of the experimenter. These experiments have questioned the ability of users to generate valid opinions and consequently the use of opinions as an evaluation measure within N-CAL is of questionable value to those who are seeking relevant information to develop or evaluate N-CAL as part of the educational process within nursing. The reported attitudes and opinions of users' in these experiments have not been as straightforward as they first appeared to be. Indeed, ***it has been demonstrated that attitudes and opinions are not a valid or useful evaluation measure for those who seriously wish to evaluate N-CAL.***

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Chapter 6

THE CONSTRUCTION, EVALUATION AND USE OF N-CAL PACKAGES.

Introduction

This final chapter will place the observations and findings of this project within a relevant context and that context derives from the contrast between the traditional approach to N-CAL discussed in some detail in Chapter one and the approach taken in this project in terms of N-CAL package construction, evaluation and use.

1. Construction of N-CAL packages

This project, in heeding technological developments from the 1980s, used an established hardware / software combination offering a powerful graphical information environment in HyperCard on the Apple Macintosh. The N-CAL package was constructed by a nurse educationalist, with relative ease, in small discrete stages with the development of modules gradually progressing to the completed N-CAL package. The attraction of this approach to developing N-CAL packages must be clear to most educationalists - not only is the end product likely to better reflect the real needs of educationalists, for they know what is required within a curriculum, but there is no longer a need to employ intermediaries such as a programmer or analyst and in this way the development time and cost is reduced. In addition the interface of the N-CAL package was intuitive to users and represented a quantal leap in terms of usability of the package over what is presently available to nurse education.

The package developed for this project was constructed using the Apple Macintosh and Hypercard but this method of construction is not restricted to this hardware / software combination and a version of it has been written for MS DOS compatible computers running 'Windows' within the authoring environment 'Plus'. This version of the N-CAL package is being utilised by a commercial company to train nurses in the use of their Nursing Information System (Jones and McCormac 1991b). Both of these N-CAL packages are functionally equivalent for the look and feel of these packages or the interface design are comparable even though they run on different hardware. Authoring environments which are intuitive to use are becoming more prominant across different hardware but, unfortunately, this does not extend to the BBC microcomputer for with its processing power, it is not and never will be capable of running information tools like HyperCard or Plus.

It has not been the primary aim of this project to develop an N-CAL package. The project is better described in terms of action research, where the package was used as a vehicle through which different methods of evaluating N-CAL packages were explored. Priority was given to evaluating the package during its iterative development. Indeed, if the development process of N-CAL package construction is incorrect or incomplete then, it will follow that, the end product of that process will be flawed and any outcome measured as a result of using the N-CAL package will reflect this. Thus, it was essential that the evaluations concentrate upon measures which might have a contribution to make towards the the development process. The next section will discuss the results of the evaluations completed in this project and consider these findings in relation to future N-CAL developments.

2. Evaluation of N-CAL packages

Regretfully, there is no short cut to developing N-CAL packages of quality. Those individuals developing learning packages need answers to questions which relate to the usability of the package under construction, questions such as: Where do users experience difficulties in using the package; Where are they unable to complete the tasks set within the N-CAL package; Why are users experiencing difficulties or making errors; Is the content of the package appropriate, relevent and accurate? Performance measures from different subjects, whilst often time consuming to collect and analyse, proved to be the most useful measures. These measures provided hard evidence of developmental changes required to improve the usability of the package. User performance measures identified where difficulties and errors occurred to the extent that they interfered with users achieving the goals of the package, either usability goals or educational goals. Thus, not only were they used as formative evaluators but also summative evaluators - formative, where data provided evidence which was acted upon in the iterative development of the package and summative, where data provided evidence of the extent to which users achieved the goals and

objectives of the N-CAL package under evaluation.
In contrast to the findings of the first three experiments measures used in Experiments four and five could not contribute in any way to the construction of the package nor did they provide any useful information in relation to the outcome of using the N-CAL package. The final two experiments (four and five) reported in Chapter five questioned the value of using opinions and attitude measures, for they are often not what they appear. This is a view which gains support from nurse education, itself, where it has been demonstrated that opinions and attitudes are associated with various factors. For example, Ball et al (1985) found that nurses attitudes towards computers improved after contact with computers and when their knowledge about computer concepts was increased. Others have identified relationships between demographic variables and attitudes towards computer-use, for example, McConnel et al (1989) identified age, level of education and the number of years nurses had worked on a Unit as having a reliable effect upon their attitude towards computer-use. It is also a view which gains considerable support from the extensive research reported within Psychology in which the generation of attitudes and opinions formed as part of an individuals belief system has been shown to be influenced in a number of different ways by a multitude of different things (Festinger 1964). Even if it were possible for users to generate valid opinions it is difficult to imagine how they could be used to contribute in any significant way to the development of an N-CAL package. What is needed is hard evidence of the process of interaction or package use with resulting refinements of packages until the goals of the package are achieved.

The measures used in the first three experiments (notably user performance measures) have greatest significance for the future development of N-CAL packages within nurse education. User performance measures provide a means to achieving quality packages if data is systematically collected and used in the construction of any N-CAL package.

Having identified a framework for the production of N-CAL packages it remains to be seen how N-CAL might be used in a nursing curriculum? The next section will briefly reitierate the ways in which N-CAL has been used within nurse education thus far and identify the contribution that this project might have towards the integration of N-CAL in a nursing curriculum.

3. Use of N-CAL

There are ***two fundamental difficulties*** associated with the integration of N-CAL into a nursing curriculum which derive from what is meant by N-CAL. On the one hand, N-CAL means specific nursing orientated learning packages on the computer, whilst on the other hand, it has been used to mean 'computer awareness' or learning about computer-use.

The first difficulty which relates to specific N-CAL packages has been the nursing content which these packages have addressed. The majority of N-CAL packages available in the UK have focussed upon isolated aspects of a nursing curriculum and no coherent strategy has been evident to present information which is crucial to any nursing curriculum. In addition the claimed potential of N-CAL to simulate nursing practice is not illustrated by those packages available to nurse education and this is attributed to the obsolete computing facilities which remain within Colleges of Nursing. The packages which are available are of value to only a few learners and a minority of educationalists use them in a nursing curriculum. Not surprisingly, this form of N-CAL has declined in popularity in recent years. Educationalists expectations have been raised but the reality has often been electronic page turners addressing an area of nursing which they themselves could present in a more complete way. Unfortunately, Nursing Colleges have not been in a position to take advantage of high quality N-CAL packages within their nursing curriculum and as a result N-CAL in the form of dedicated nursing packages have failed to impact the nursing curriculum.

If N-CAL packages are to gain widespread acceptance and integration in the nursing curriculum then, the package content must demonstrate that it is meaningful and relevant to nursing practice and nurse education. This project used a novel presentation of N-CAL to describe the concept and stages of the Nursing Process. The information contained within the N-CAL package represents nursing information which is at the heart of nursing and is crucial to the understanding and use of Nursing Information Systems (NISs). NISs have become a major area of expenditure for Health Authorities / Boards for they offer a means of managing nursing resources and as such they are increasingly in evidence as tools used by nurses to assist in the management of nursing and the delivery of nursing care. NISs are an element of 'Nursing Informatics', defined by Graves (1989) as "..a combination of computer science, information science and nursing science designed to assist in the management and processing of nursing data, nursing information and nursing knowledge to support the practice of nursing and the delivery of nursing care". All NISs include a Care Planning section which is underpinned by the Nursing Process. The Introductory module of the Nursing section of the N-CAL package constructed and evaluated in this project uniquely demonstrates how the Nursing Process can be used to build a Nursing Care Plan.

The second difficulty, stems from the diversionary definition adopted by the ENB N-CAL Project which directed attention towards hands-on experience of using computers to learn about word processors, spread sheets, databases and refers to the use of different software packages. As a result many Colleges have attempted to implement 'computer awareness' into the nursing curriculum (Dowglass and Proctor 1991). This raises the question - What represents core curriculum nursing material? In answering this important question it may be helpful to identify levels of competence within the area of Nursing Informatics. Three levels of competences have been described by the International Medical Informatics Association (IMIA) Working Group 8 on Nursing Informatics (Peterson 1988) :

1. User level - describing an individual with the ability to use the tools of Nursing Informatics.
2. Developer level - describing an individual with the an ability to participate knowledgeably in development of Nursing Informatics.
3. Expert level - describing an individual who can direct development and implementation of Nursing Informatics, act as a consultant, evaluator and researcher.

Core nursing curriculum must surely be at the first level, that is nurses with the ability to use the tool, not all nurses will be expected to contribute to the development of such tools. That is not to say that nurses should only be prepared as users, for example all nurses should understand how the information within a NIS is used to manage nursing resources and how it affects their work and the care of patients. Nurse managers, on the other hand, will certainly be expected to have sufficient knowledge to function at the second level and contribute towards the development of NISs as would many nurse educationalists. Only a few specialists, however, will be required to have sufficient skills of Nursing Informatics to the level of expert. Taken in this context Pre-Registered Nurse Education will need to provide sufficient skills for nurses to

function at the user level and Post-Registered Nurse Education becomes an appropriate time for increasing that level of competence to the second level.
Where is there a need for nurse learners to become familiar with various software packages such as spreadsheets or statistical packages on the computer and how does this relate to nursing? The vagueness of the term 'computer awareness' has often been used within Colleges of Nursing to defend hands-on experience which is quite inappropriate for nurse learners. Is it not more appropriate that they learn how to use the tools of their trade, that is Nursing Information Systems. This project has created an N-CAL package which is directly relevant to the nursing professions' use of NIS. In addition it has contributed towards the design and development of the Advanced module of the Nursing section which simulates an existing NIS.

Before N-CAL is capable of playing a significant role in the Project 2000 curriculum for nurse education it needs to be appropriately resourced. If N-CAL is to be used as a legitimate teaching method then it must be given adequate resources for it to function effectively. Resources are required to upgrade existing equipment within Colleges of Nursing and resources are required to familiarise educationalists with the technology. It takes time to develop N-CAL packages that are meaningful and useful and it would be quite inappropriate to rely on individual, enthusiastic, educationalists working on available equipment as an additional part of their work.

This project did not conclusively identify a difference between the experience of members in a group using the N-CAL package, however, the results of Experiments four and five did suggest that the experience of those actually using the computer to input information (the operator) may be different to those who were observing. Further research is needed to clarify this for it would have important consequences for the education of nurses if the learning experience for members of a group differed (dependant upon the extent to which individuals in the group used the computer). Whilst some authors have advocated the use of N-CAL as a group activity and suggested that the interaction within a group may be an important factor (Billings 1986, Harvey and Vaughan 1990) group activities at the computer does not reflect the use of technology by nurses in their working environment. Nurses will not use these tools in groups, they will use them to develop Nursing Care plans for the patients under their care or to manage a budget for their area of responsibility. If nurse education is seriously preparing nurses for the use of these tools then this is unlikely to be achieved in group activities at a computer. ***Nurse learners require experience of using computers which is individual and relevant to nursing .***

4. What of the Future?

Continuing the pragmatic approach to N-CAL construction and evaluation the next stage of this work would be to evaluate the Advanced modules of the N-CAL package. It is proposed that an evaluation of the delivery system and the nursing content is required. Although the design of the delivery system for the Advanced modules has many similar features to the Introductory modules, there are some additional features which were essentially a simulation of the functionalities of an existing Nursing Information System which facilitates the building of Care Plans by users. For example, in the Advanced module of the Nursing section users were given the opportunity to build Care Plans for different patients / client groups. Users are required to select a patient problem and transfer the selected problem onto a Care Plan. They are encouraged to explore patient goals and nursing interventions associated with the selected problem. For every problem, identified by the user as being relevant for the specific patient about whom they have recieved information germane to the assessment stage of the Nursing Process, goals and interventions are also selected and transferred onto the Care Plan by the user. As the Care Plan grows in size users scroll over to the next page to visualise all the components of care. There are three immediately recognisable features of the delivery system which are used in this Advanced module described in the process above:

i) selecting and transferring words from one list to another, described in the learning package as select 'n' snatch,

ii) exploring related groupings of information, that is exploring goals and interventions associated with a specific problem and

iii) scrolling down pages.

These features of the delivery system are introduced in a rewritten Advanced module of the Tutorial section and users are able to practise these skills by building dinner menus for different individuals - for example, a three course menu for a vegetarian, a child and an adult.

It is these additional features of the delivery system which should be evaluated through observing users' visible behaviour and recording their formal interactions through a trace facility. The extent to which users are able to build the dinner menus would be a measure of users achievement of performance goals and this part of the evaluation could be completed by non-nursing individuals. The initial evaluations could be of the revised version of the Advanced module of the Tutorial section to evaluate the additional features of the delivery system. The next evaluations might use nurse educationalists and include the Advanced module of the Nursing section to evaluate both the delivery system and the nursing content. The additional nursing content which needs to be evaluated is the information germane to each client group to determine its accuracy and relevance. Whilst the information was identified from literature reviews its relevence and accuracy would still need to be verified by experts in those areas and verbal protocols may be recruited to assist in the evaluations here. In the final experiments qualified nurses could be used as subjects and user performance measures could again be utilised to evaluate users visible behaviour and formal interactions. The extent to which specific educational objectives, outlined in Chapter three in terms of the building of Care Plans, were achieved by this group of subjects could be identified from the actual Care Plans the users completed for each individual patient or client.

Since the Advanced module of the Nursing section was designed to simulate an existing Nursing Information System then the design of the delivery system was restricted by the specific functions of that Information System. An additional area of research might be to identify the most approriate method of representing the build up of Care Plans on the computer. For example, should lists of information be presented by overlaying windows of information, where one window obstructs some of the information on the Care Plan or should the lists of information be displayed in pull-down menus, where the information is only visible for the length of time that the user is selecting? Should the Care Plan be visible to the user at all times when selecting appropriate care or should the Care Plan be iconised or reduced to a small window which can then be opened out to display its contents when required? What words and icons, used in the Care Plan building, best convey their meaning to users. For example, should arrows be used adjacent to problems to indicate the means to exploring goals associated with the problem or should a menu displaying the word 'goal' be used? The questions being asked relate to the design of the interface and a good example of this type of research is reported by Jones and Buchanan (1989) comparing textual displays with graphical displays. Both text and graphics were used to represent the same information to subjects in their experiments and they concluded that the graphical displays were better understood by users.

The most appropriate design of the interface will, perhaps, only be identified from a more theoretical approach to evaluation. What is needed is a model of user interaction. What picture do users have of the information presented on the screen? If a model of user interaction represents how they see the information then that model can drive the design and development of future systems. The development of the theory of user-interaction requires data which accurately reflects what users do at the interface. The data is then analysed for patterns and from the collection of data, theories gradually emerge. The approach taken in this project was purely pragmatic. Data was collected using different user performance measures to illustrate what users do at the interface. Since the development of theory comes from data which epitomises what users do at the interface then the data collection in this project represents the first tentative stage towards developing a theory.

5. Conclusions

Nurses need to be prepared for the kind of technology which they will be using as tools within their profession and as such learning packages which are relevant to the nursing professions' use of computers should be put in place. However, if packages of quality are to be developed, and they will need to be if N-CAL is to be integrated widely into the curriculum of nurse education, then more attention should be paid to technology enabling easier development and use. It is surprising that those who have directed the development of N-CAL packages have ignored significant technological developments from the 1980s which have implications for the design and development of N-CAL. Indeed, this is inexcusable when the usability of an N-CAL package is evaluated, for usability relates to the ease with which learners transfer information from the computer and the ease with which the developer transfers information into the computer. The technology of the 1980s represents improvements in the transfer vehicle but, on its own, it will not ensure success. This can only be guaranteed through extensive evaluation of the development process.

Detailed evaluation is needed during the construction of an N-CAL package and this project has demonstrated how user performance measures can be utilised to record the development / evaluation cycle. These measures are time consuming, but this is what it takes, especially as N-CAL packages become more complex and actually simulate nursing practice. Greater attention must be directed towards the production and evaluation of N-CAL packages to ensure their quality. This route is more likely to lead to the widespread acceptance and integration of N-CAL in the nursing curriculum.

5.1 Generalisation of Results

The results of the first three experiments represent an evaluation of the usability of the interface of the N-CAL package under development. It is suggested that this approach to evaluation (where subjects are selected for the experiments depending on their background of experience in relation to the stage of development of the package) is applicable to developing N-CAL or CAL packages generally.

The subjects in the final two experiments were two subsequent intakes of student nurses from the South College of Nursing, Glasgow. Since Colleges of Nursing utilise a common entry level standard, it is not unreasonable to assume that the student intake in this College is representative of individuals commencing nurse education in other Colleges of Nursing. Subjects undertook the final two experiments during their first week of attendance at the College of Nursing, thus, any direct influence that the College may have is likely to have been negligible other than where explicitly stated in the results section. It is concluded that the results of the final two experiments are generalisable across student nurse intakes to Colleges of Nursing.

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Appendix 1.

Experiment 1. Broad Aims and Objectives

Aim:

1. To obtain information in relation to the delivery system from both naive and experienced Apple Macintosh computer users.

Objectives:

1. To identify the extent to which the evaluation measures were capable of providing useful information which could contribute to the development of the N-CAL package.
2. To identify the extent to which users were able to complete the Tutorial section, through the completion of specific tasks.
3. To identify the relative strengths and weaknesses of the computing style which led to positive opinions being expressed or which led to innapropriate use.

Experiment 2. Broad Aims and Objectives

Aim:

1. To identify whether nurse edcuationalists were able to apply their newly-acquired computer-use skills to access the nursing information contained within the N-CAL package.

Objectives:

1. To identify the extent to which the evaluation measures were capable of providing useful information which could contribute to the development of the N-CAL package.
2. To identify the extent to which users were able to complete the Tutorial section and the Introductory Nursing module, through the completion of specific tasks.
3. To identify the relative strengths and weaknesses of the computing style which led to positive opinions being expressed or which led to innapropriate use.
4. To determine the accuracy of the nursing content of the N-CAL package.

Appendix 1. cont.

Experiment 3. Broad Aims and Objectives

Aim:

1. To identify whether practising nurses undertaking a course in Systematic Nursing were able to apply their newly-acquired computer-use skills to access and comprehend the nursing information contained within the N-CAL package.

Objectives:

1. To identify the extent to which the evaluation measures were capable of providing useful information which could contribute to the development of the N-CAL package.
2. To identify the extent to which users were able to complete the Tutorial section and the Introductory Nursing module, through the completion of specific tasks.
3. To identify the relative strengths and weaknesses of the computing style which led to positive opinions being expressed or which led to innapropriate use.
4. To identify whether the N-CAL package engendered any changes in learners attitudes towards N-CAL in general.

Appendix 2. Features of the Apple Mac Computer

1A. The MOUSE

EASY TO USE |.......|.......|.......|.......|.......|.......|.......| DIFFICULT TO USE

2A. CONTROL THROUGH THE PACKAGE

DIFFICULT TO USE |.......|.......|.......|.......|.......|.......|.......| EASY TO USE

3A. NAVIGATION ICONS move on, move back, homebase

DIFFICULT TO USE |.......|.......|.......|.......|.......|.......|.......| EASY TO USE

4A. TEXT BUTTONS

EASY TO USE |.......|.......|.......|.......|.......|.......|.......| DIFFICULT TO USE

5A. RADIO BUTTONS

DIFFICULT TO USE |.......|.......|.......|.......|.......|.......|.......| EASY TO USE

6A. PROGRESS THERMOMETER

EASY TO USE |.......|.......|.......|.......|.......|.......|.......| DIFFICULT TO USE

7A. MOVING THE FINGER POINTER AROUND THE SCREEN

EASY TO USE |.......|.......|.......|.......|.......|.......|.......| DIFFICULT TO USE

8A. TEXT PRESENTATION VARIETY OF SIZES AND EMPHASIS

DID NOT ENHANCE USE |.......|.......|.......|.......|.......|.......|.......| ENHANCED USE

9A. GRAPHICS, VARIETY OF PICTURES

ENHANCED USE |.......|.......|.......|.......|.......|.......|.......| DID NOT ENHANCE USE

10A. SCREEN PRESENTATION different background shadings

ENHANCED USE |.......|.......|.......|.......|.......|.......|.......| DID NOT ENHANCE USE

Features of the Apple Mac Computer

1B. The MOUSE

LIKED USING |.......|.......|.......|.......|.......|.......|.......| DISLIKED USING

2B. CONTROL THROUGH THE PACKAGE

DISLIKED USING |.......|.......|.......|.......|.......|.......|.......| LIKED USING

3B. NAVIGATION ICONS move on, move back, homebase

DISLIKED USING |.......|.......|.......|.......|.......|.......|.......| LIKED USING

4B. TEXT BUTTONS

LIKED USING |.......|.......|.......|.......|.......|.......|.......| DISLIKED USING

5B. RADIO BUTTONS

LIKED USING |.......|.......|.......|.......|.......|.......|.......| DISLIKED USING

6B. PROGRESS THERMOMETER

DISLIKED USING |.......|.......|.......|.......|.......|.......|.......| LIKED USING

7B. MOVING THE FINGER POINTER AROUND THE SCREEN

LIKED USING |.......|.......|.......|.......|.......|.......|.......| DISLIKED USING

8B. TEXT PRESENTATION VARIETY OF SIZES AND EMPHASIS

DISLIKED |.......|.......|.......|.......|.......|.......|.......| LIKED

9B. GRAPHICS, VARIETY OF PICTURES

LIKED |.......|.......|.......|.......|.......|.......|.......| DISLIKED

10B. SCREEN PRESENTATION different background shadings

LIKED |.......|.......|.......|.......|.......|.......|.......| DISLIKED

Appendix 2 cont. Definitions of the Features of the Apple Mac Computer.

The MOUSE - the device used to input information into the computer.

CONTROL THROUGH THE PACKAGE - the extent to which you were able to direct the information on the screen of the computer.

NAVIGATION ICONS move on, move back, homebase - the extent to which you were able to control your movement in the learning package.

TEXT BUTTONS - clicking over a word to indicate to the computer that you wished more information about that word.

RADIO BUTTONS - clicking over the small circles, as in the multiple choice questions, to indicate your choice.

PROGRESS THERMOMETER - the use of the symbol to gain information ie. about where you were in the programme.

MOVING THE FINGER POINTER ROUND THE SCREEN -using the mouse to move the pointer to the desired position on the screen.

TEXT PRESENTATION VARIETY OF SIZES AND EMPHASIS - the use of different sizes of and types of letters to emphasise some words.

GRAPHICS, VARIETY OF PICTURES - the use of different pictures to illustrate examples in the package.

SCREEN PRESENTATION different background shadings - the use of different backgrounds to present information on the screen.

Please note. The definitions listed above were adjacent to each feature on the questionnaires illustrated in figures 4.1. and 4.2.

Appendix 2.
cont.

Features of the BBC Computer

1A. The KEYBOARD

DIFFICULT TO USE |.......|.......|.......|.......|.......|.......|.......| EASY TO USE

2A. CONTROL THROUGH THE PACKAGE

EASY TO USE |.......|.......|.......|.......|.......|.......|.......| DIFFICULT TO USE

3A. INSTRUCTIONS TO PRESS THE SPACE BAR move on. TYPE END OR TYPE B move back

EASY TO USE |.......|.......|.......|.......|.......|.......|.......| DIFFICULT TO USE

4A. TYPE IN A WORD THEN PRESS RETURN

DIFFICULT TO USE |.......|.......|.......|.......|.......|.......|.......| EASY TO USE

5A. TYPE IN THE NUMBER OF YOUR CHOICE

DIFFICULT TO USE |.......|.......|.......|.......|.......|.......|.......| EASY TO USE

6A. FUNCTION KEY F1 FOR HELP

EASY TO USE |.......|.......|.......|.......|.......|.......|.......| DIFFICULT TO USE

7A. TYPING

DIFFICULT TO USE |.......|.......|.......|.......|.......|.......|.......| EASY TO USE

8A. TEXT PRESENTATION USE OF COLOUR FOR EMPHASIS

ENHANCED USE |.......|.......|.......|.......|.......|.......|.......| DID NOT ENHANCE USE

9A. GRAPHICS, PICTURES AND SYMBOLS

DID NOT ENHANCE USE |.......|.......|.......|.......|.......|.......|.......| ENHANCED USE

10A. SCREEN PRESENTATION different background colours

ENHANCED USE |.......|.......|.......|.......|.......|.......|.......| DID NOT ENHANCE USE

Features of the BBC Computer

1B. The KEYBOARD

DISLIKED USING |.......|.......|.......|.......|.......|.......|.......| LIKED USING

2B. CONTROL THROUGH THE PACKAGE

LIKED USING |.......|.......|.......|.......|.......|.......|.......| DISLIKED USING

3B. INSTRUCTIONS TO PRESS THE SPACE BAR move on. TYPE END OR TYPE B move back

DISLIKED USING |.......|.......|.......|.......|.......|.......|.......| LIKED USING

4B. TYPE IN A WORD THEN PRESS RETURN

DISLIKED USING |.......|.......|.......|.......|.......|.......|.......| LIKED USING

5B. TYPE IN THE NUMBER OF YOUR CHOICE

LIKED USING |.......|.......|.......|.......|.......|.......|.......| DISLIKED USING

6B. FUNCTION KEY F1 FOR HELP

DISLIKED USING |.......|.......|.......|.......|.......|.......|.......| LIKED USING

7B. TYPING

DISLIKED USING |.......|.......|.......|.......|.......|.......|.......| LIKED USING

8B. TEXT PRESENTATION USE OF COLOUR FOR EMPHASIS

LIKED |.......|.......|.......|.......|.......|.......|.......| DISLIKED

9B. GRAPHICS, PICTURES AND SYMBOLS

LIKED |.......|.......|.......|.......|.......|.......|.......| DISLIKED

10B. SCREEN PRESENTATION different background colours

DISLIKED |.......|.......|.......|.......|.......|.......|.......|LIKED

Appendix 2. cont. Definitions of the Features of the BBC Computer.

The KEYBOARD - the device used to input information to the computer.
CONTROL THROUGH THE PACKAGE - the extent to which you were able to direct the information on the screen of the computer.
INSTRUCTIONS TO PRESS THE SPACE BAR move on, TYPE END OR TYPE B move back - the extent to which you were able to control your movement in the learning package.
TYPE A WORD THEN PRESS RETURN - typing a word and then pressing return to indicate to the computer that you wished more information about that word.
TYPE IN THE NUMBER OF YOUR CHOICE - typing in a number as in the menu options to indicate your choice.
FUNCTION KEY F1 FOR HELP - the use of the red F1 key to get information for example about where to go.
TYPING - typing information on the screen.
TEXT PRESENTATION USE OF CLOUR FOR EMPHASIS - the use of different colours to emphasise some words.
GRAPHICS, PICTURES AND SYMBOLS - the use of pictures or symbols to illustrate examples in the package.
SCREEN PRESENTATION different background colours - the use of different backgrounds to present information on the screen)

Please note. The definitions listed above were adjacent to each feature on the questionnaires illustrated in figures 4.4. and 4.5.

Appendix 2.
cont.

Given the opportunity which computer would you like to use to learn more about Nursing related topics?

BBC............. Mac........... (tick as appropriate)

Please give reasons for your choice:

....

....

....

....

....

....

If you wish to make any general comments about either or both of the computers or learning packages please do so below:

....

....

....

....

....

....

....

....

....

....

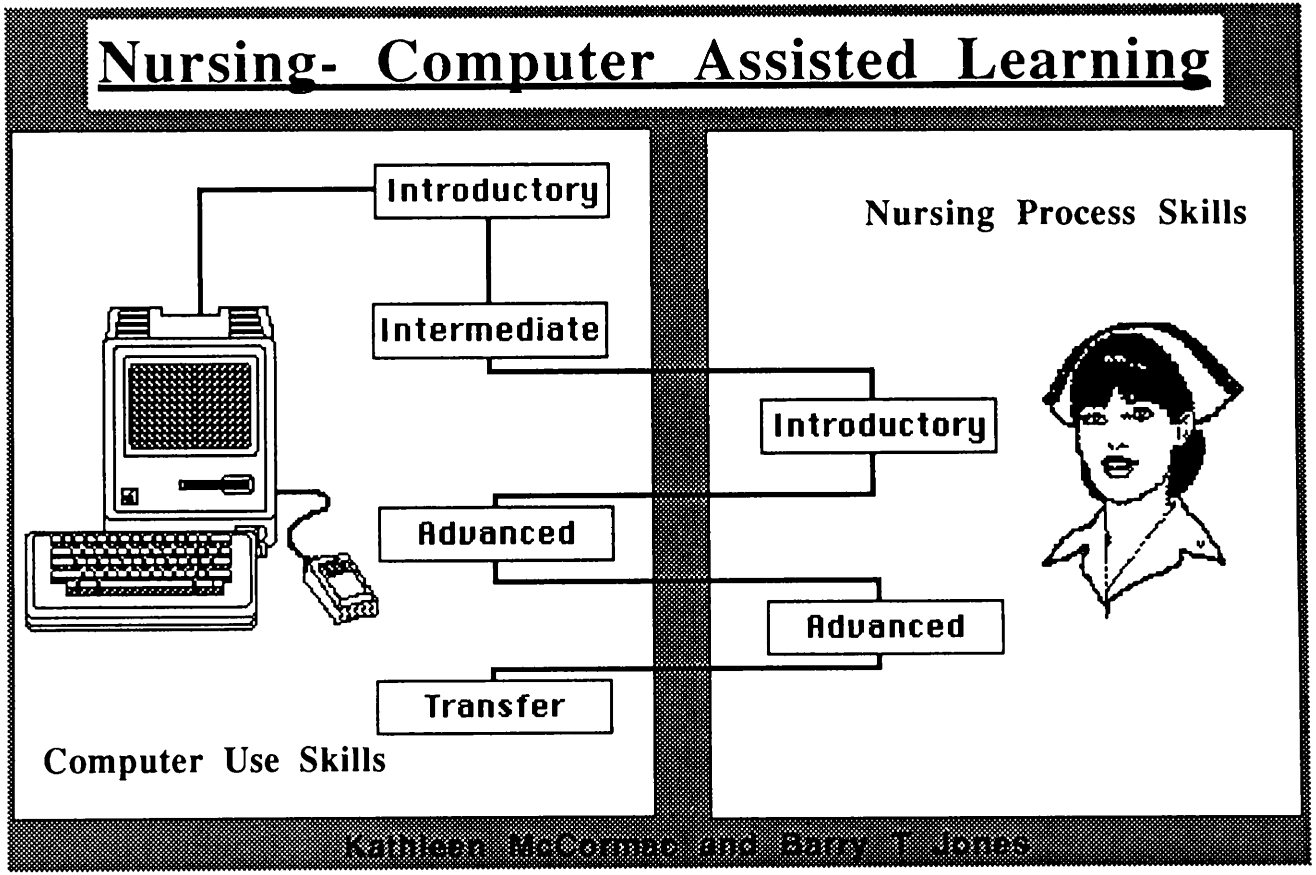
Thankyou For Your Co-operation

Appendix 3. HyperTalk the programming language of HyperCard

Within the HyperCard environment the programming language HyperTalk can be associated with five basic objects - buttons, fields, cards, backgrounds and stacks:

Buttons refer to any screen sensitive area designated by the author and this includes text, icons and pictures.
Fields are used to present textual information on the screen. This enables the author to quickly change any of the text in the same way that a user would alter a wordprocessing document.
Cards represent the information which is visible on any single screen, but it also includes information which only becomes visible as the user initiates the actions indicated on the screen resulting in more detailed information being displayed.
Backgrounds contain the information which is shared by a number of different cards, for example, the icon of a book is shared by most of the cards in the Introductory Nursing module and is therefore written on the background.
Stacks are a number cards which make up a module in the N-CAL package.

Appendix 3 illustrates these different objects using a selection of the HyperCard modules from the N-CAL package constructed for this project. Examples of simple programming in HyperTalk are described alongside relevent printouts from the N-CAL package.



The Plan above illustrates the 6 different modules of the N-CAL package. To access any of the modules, the user would move the pointer over one of the text buttons and press the button on top of the mouse. This creates a mouseUp message which is handled by HyperCard:

HyperTalk programming under "Introductory":

```
on mouseUp
  visual effect dissolve slowly to gray
  visual effect barn door open slow
  go stack "NP-introductory"
end mouseUp
```

These 5 lines of programming are initiated when the mouse button is pressed and released over the screen sensitive area "Introductory". This message fades the screen picture to grey opening the HyperCard stack called "NP-introductory" creating an effect on the screen as though curtains are opened to display the new stack.

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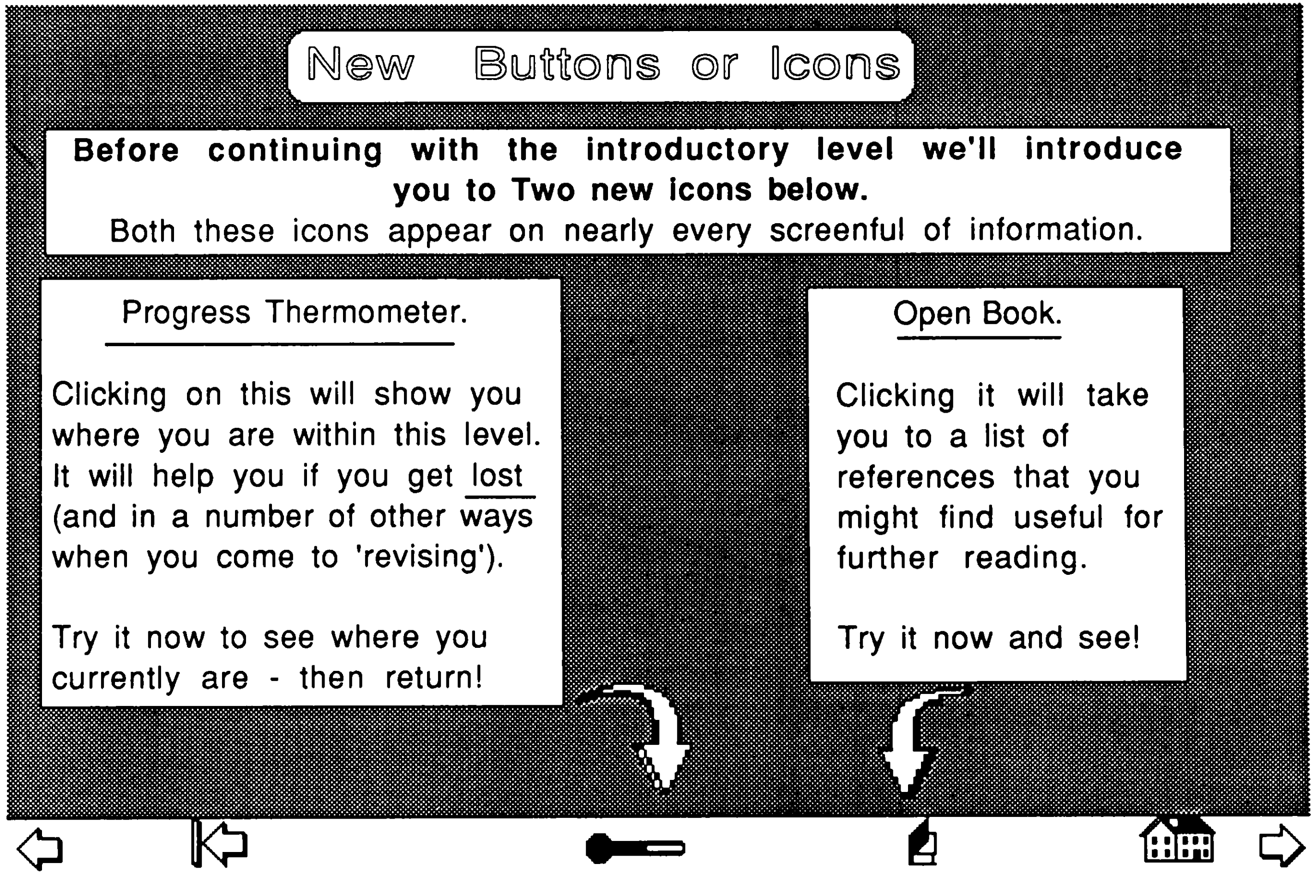
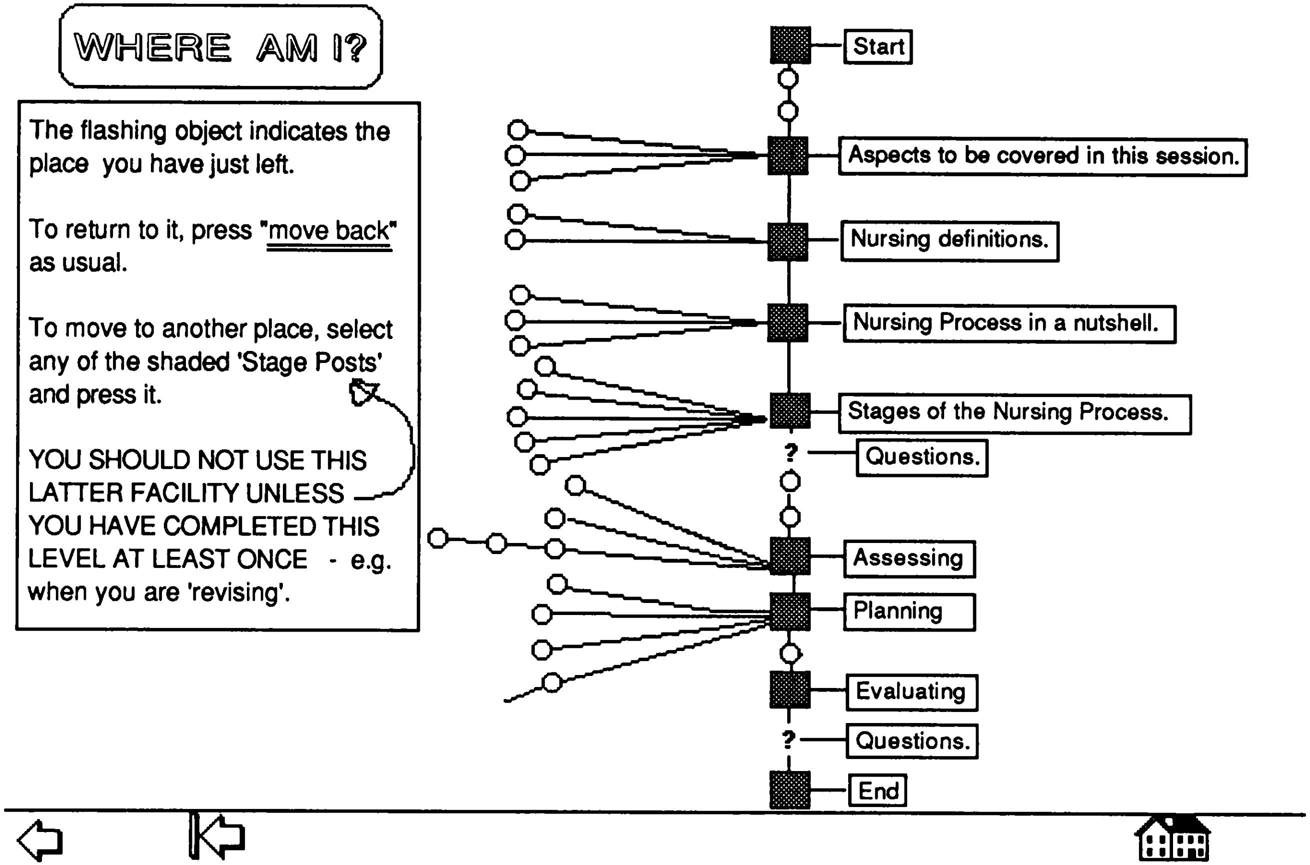


Object orientated programming refers to the modularisation of HyperTalk so that a few lines of programming are directly associated with the object of interest. For example, there is programming associated with the icon called the "Progress Thermometer" which is a designated button or screen sensitive area:

```
on mouseUp
  global bye
  get the short name of this card
  put it into bye
   visual iris open slowly
  go to card "plan of stack"
end mouseUp
```

"Bye" is a variable. The name of the card or the screen is held by this variable and it will be used to indicate the users progress through this module represented on the card called "plan of stack". The screen displays this new card with a special effect which opens from the centre of the screen.



The illustration above is of the card "plan of stack", it represents the information flow of the stack "Introductory Nursing module". The users position in this module will be indicated by a flashing object. The user can move to any of the major stage posts as indicated or they can return using the backward pointing arrow:

HyperTalk programming associated with arrow:

```
on  mouseUp
 global  bye
 visual  wipe  right  slowly
  go  to  card  bye
end  mouseUp
```

The variable "bye" is used to return users to the card or the screen they have left for it contains the name of the card. The visual effect used this time indicates backward movement.
Each of the stage posts contain a few lines of HyperTalk, if initiated the card or screen indicated would be displayed.

Care Plan - example

In relation to the Assessment of Mr McTaggart's Breathing, the problems will be listed in order of priority, a goal will be identified for each problem and a plan of action decided upon to meet each goal. As you follow the instructions, the form will build up below.

Problems

click over this text to build up the form

This screen is designed to demonstrate how the the Nursing Process is used to build a Care Plan. Before reaching the screen illustrated above users have already been exposed to Mr McTaggarts Personel Details and Assesment Profile, so they are already aware of three problems pertaining to this patient.

Users are invited to click on the button illustrated to build the patient Care Plan. The HyperTalk programming under this button is quite simply:

```
On mouseUp
  show card field "headings"
End mouseUp
```

When users intiate this action a text field which has been named "headings", previously hidden from the users, is made visible to them.
As the next few illustrations demonstrate, an number of text fields has been hidden from the user when this card or screen opens.

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Care Plan - example

In relation to the Assessment of Mr McTaggart's Breathing, the problems will be listed in order of priority, a goal will be identified for each problem and a plan of action decided upon to meet each goal. As you follow the instructions, the form will build up below.

Problems **Goals / Aims** **Plan of Actions**

click over this text to list the first problem

The text field called "headings" is now visible. Users are now invited to click over another button to list the first problem.

The HyperTalk programming under this button is quite simply:

```
On mouseUp
  show card field "1st problem"
End mouseUp
```

The text field " 1st problem" will become visible once users have initiated the action associated with the button above. The button itself is a text field with HyperTalk programming written under it.

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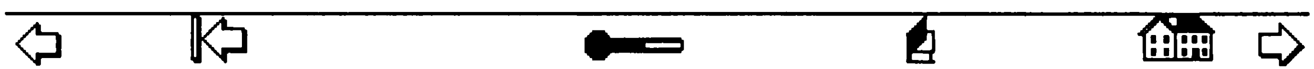
Care Plan - example

In relation to the Assessment of Mr McTaggart's Breathing, the problems will be listed in order of priority, a goal will be identified for each problem and a plan of action decided upon to meet each goal. As you follow the instructions, the form will build up below.

Problems	Goals / Aims	Plan of Actions
Dyspnoea	Mr McTaggart's dyspnoea will be alleviated	position upright, well supported with pillows;

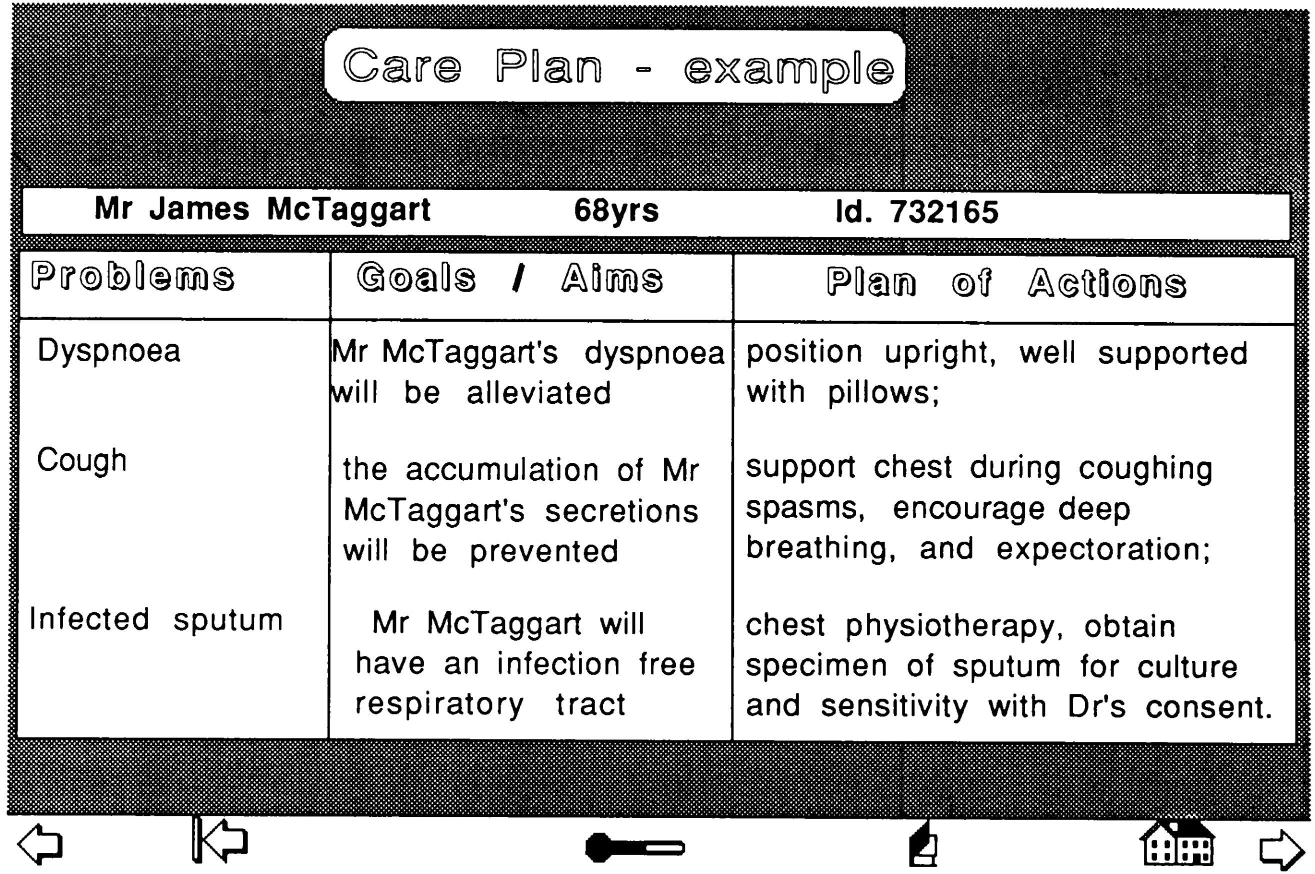
click over this text to list the second problem



The first problem with its associated goal and plan of action is now visible.
Problem by problem the Care Plan is built by users initiating the actions as instructed.

Each of the icons illustrated at the bottom of the picture, which users have come to know as navigation icons, have a few lines of HyperTalk programming associated with them and these allow the user to move in the direction of their choosing.

Users are, however, encouraged to complete the build up of the Care Plan. For example, should they attempt to move on before completing the Care Plan they will be prompted with a message which reminds them that they should complete the form but they are given the opportunity of overiding this.



Care Plan - example

Mr James McTaggart	68yrs	Id. 732165
Problems	**Goals / Aims**	**Plan of Actions**
Dyspnoea	Mr McTaggart's dyspnoea will be alleviated	position upright, well supported with pillows;
Cough	the accumulation of Mr McTaggart's secretions will be prevented	support chest during coughing spasms, encourage deep breathing, and expectoration;
Infected sputum	Mr McTaggart will have an infection free respiratory tract	chest physiotherapy, obtain specimen of sputum for culture and sensitivity with Dr's consent.

The completed Care Plan is designed to look similar to a completed form. Users should be in no doubt when they have completed the Care Plan. Similarly, the observer used during the evaluations to identify whether the task was completed can easily see if users complete this task.

Once users move from this screen or card named "Care Plan" programming is initiated which resets this card, that is the various text fields listing the different problems are hidden. Should they return to this card it will open to the blank form and they will be encouraged to build the Care Plan.

It has been illustrated that HyperTalk programming is associated with various objects seen on any single screen. Only a few lines of simple programming can create a dramatic effect.

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Appendix 3 cont.

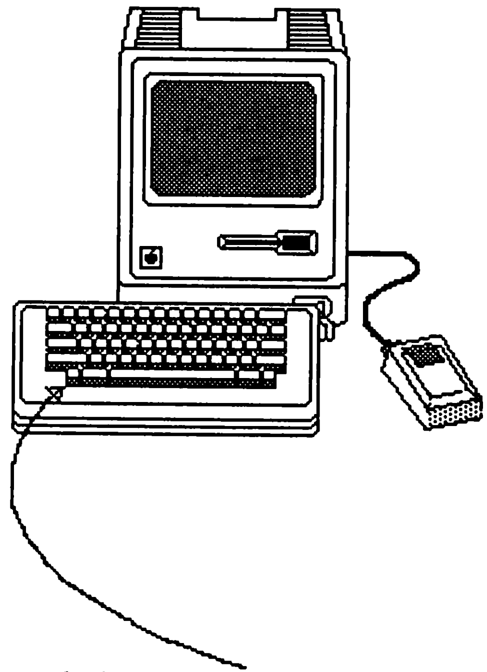
More complex lines of HyperTalk programming does exist within the N-CAL package, for example the trace used to capture the users movement through the package.
The programming at the stack level or individual modules:

```
on mouseUp
  global trace, thefile -- DEFINES THE VARIABLE CALLED TRACE & A
TEXT FILE CALLED THEFILE

  write tab & the short name of the target & tab & the long time & tab &
 the short name of this card & tab & the short name of this stack & re-
turn to file thefile --RECORD NON-DIRECTIONAL BUTTON PRESSES,
RECORD IN THE TEXT FILE WHERE THE USER CLICKED WITH THE
MOUSE, AT WHAT TIME, WHICH CARD WERE THEY AT AND WHICH
STACK OR MODULE WERE THEY VIEWING.
end mouseUp
```

The programming under the navigation icons:

```
on mouseUp
  global trace, thefile

 if trace is "on" then--IF THE TRACE WAS NOT OPERATIONAL IT WOULD
BE SET AT OFF IN WHICH CASE THESE LINES OF PROGRAMMING WOULD
BE IGNORED
    write tab & the short name of the target & tab & the long time & tab
    & the short name of this card & tab & the short name of this stack &
   return & return & return to file thefile -- RECORD DIRECTIONAL BUT-
TON PRESS, WHAT OBJECT IS BEING PRESSED, AT WHAT TIME, ON
WHAT CARD AND IN WHICH STACK WAS RECORDED IN THE TEXT FILE
FOR LATER ANALYSIS IF THE TRACE WAS ON
  end if
end mouseUp
```

INTRODUCTORY LEVEL



Welcome to the Apple Macintosh.

We're going to ask you to learn something about Macintoshes and then play a little game.

Have fun!

Press the key at the bottom left hand corner of your own keyboard to begin

REASONS FOR THIS 10-minute TRAINING EXERCISE

You are eventually going to use this computer to learn about some important things CENTRAL to your chosen career.

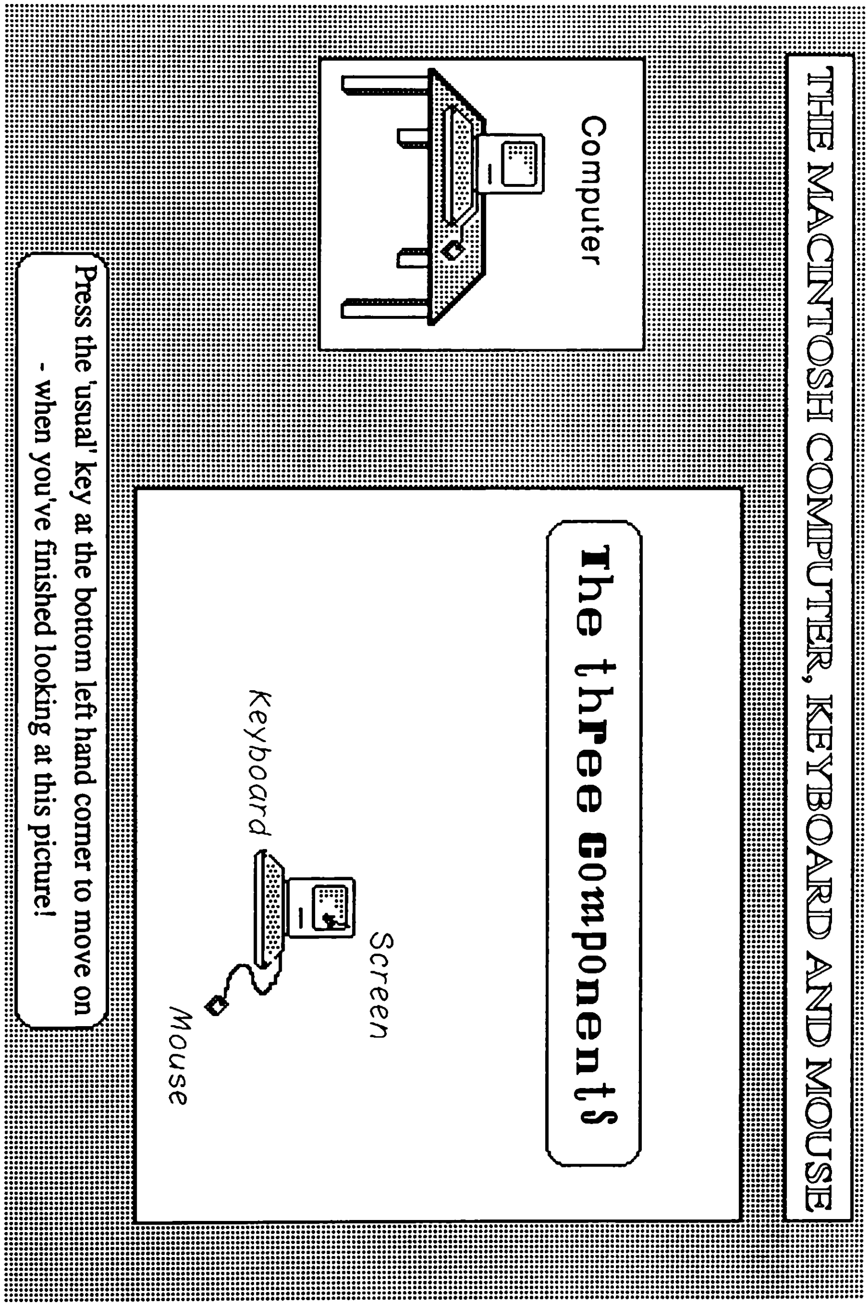
Unfortunately, there is a snag - you may have had little or no experience of using computers before!

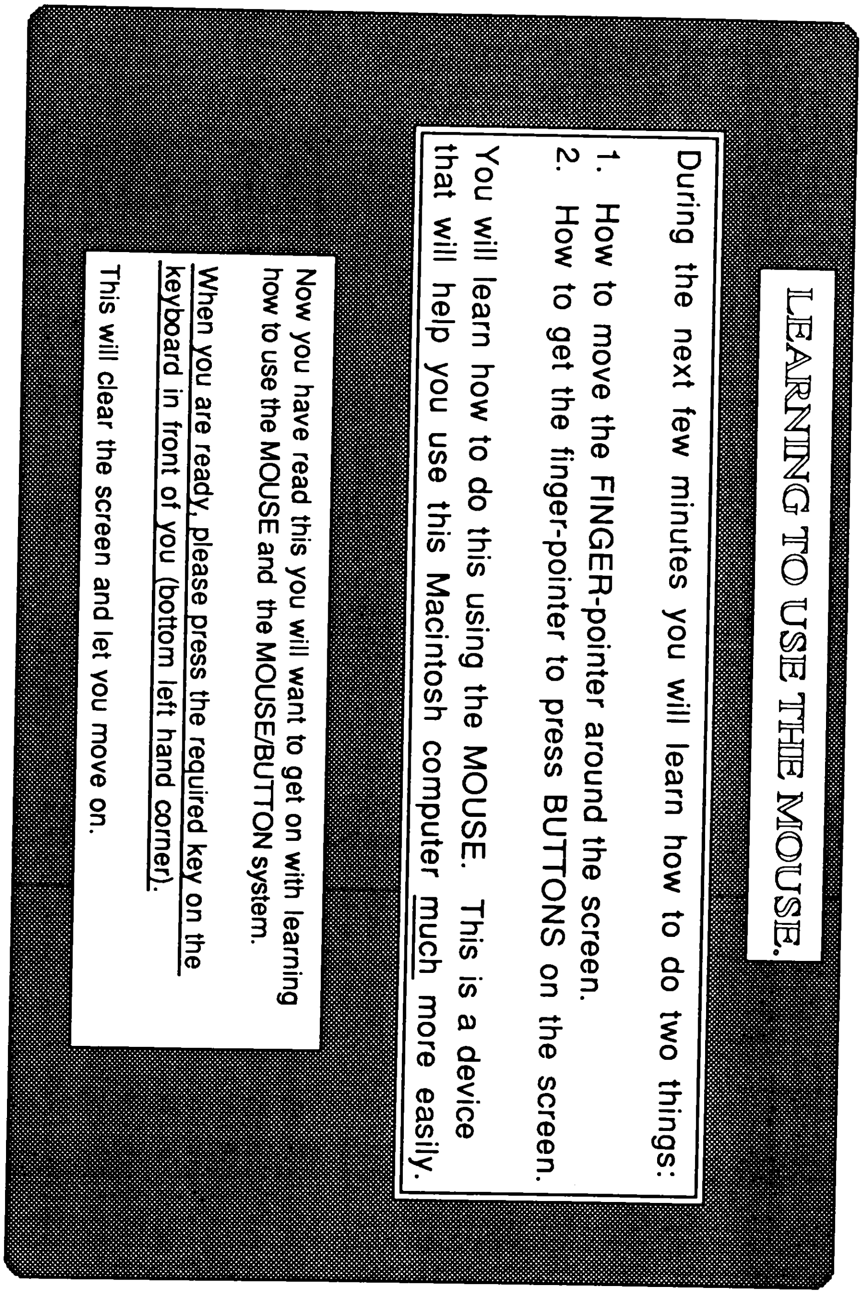
So, first, we need to ensure that you have sufficient basic SKILLS of COMPUTER-USE to let you proceed with this career-oriented learning.

Fortunately, this is very easily achieved.

The next 10 minutes is designed to ensure that you pick up these basic Computer-Use Skills if you don't already posess them (and few of you WILL already posess them).

Press the key at the bottom left hand corner of the keyboard to move on


THE MACINTOSH COMPUTER, KEYBOARD AND MOUSE
Computer
The three components
Keyboard
Screen
Mouse
Press the 'usual' key at the bottom left hand corner to move on
- when you've finished looking at this picture!


LEARNING TO USE THE MOUSE.
During the next few minutes you will learn how to do two things:
1. How to move the FINGER-pointer around the screen.
2. How to get the finger-pointer to press BUTTONS on the screen.
You will learn how to do this using the MOUSE. This is a device that will help you use this Macintosh computer much more easily.
Now you have read this you will want to get on with learning how to use the MOUSE and the MOUSE/BUTTON system.
When you are ready, please press the required key on the keyboard in front of you (bottom left hand corner).
This will clear the screen and let you move on.

MOVING THE FINGER-POINTER AROUND THE SCREEN

The MOUSE lying on the table-top has wheels. It should be positioned to the right side of the computer if you are right handed or to the left if you are left handed.

As you wheel the MOUSE around the table-top, you also move the FINGER-pointer around the screen.
- try it, now! -

If you pick up the MOUSE and wave it around in the air, the FINGER-pointer on the screen remains stationary.

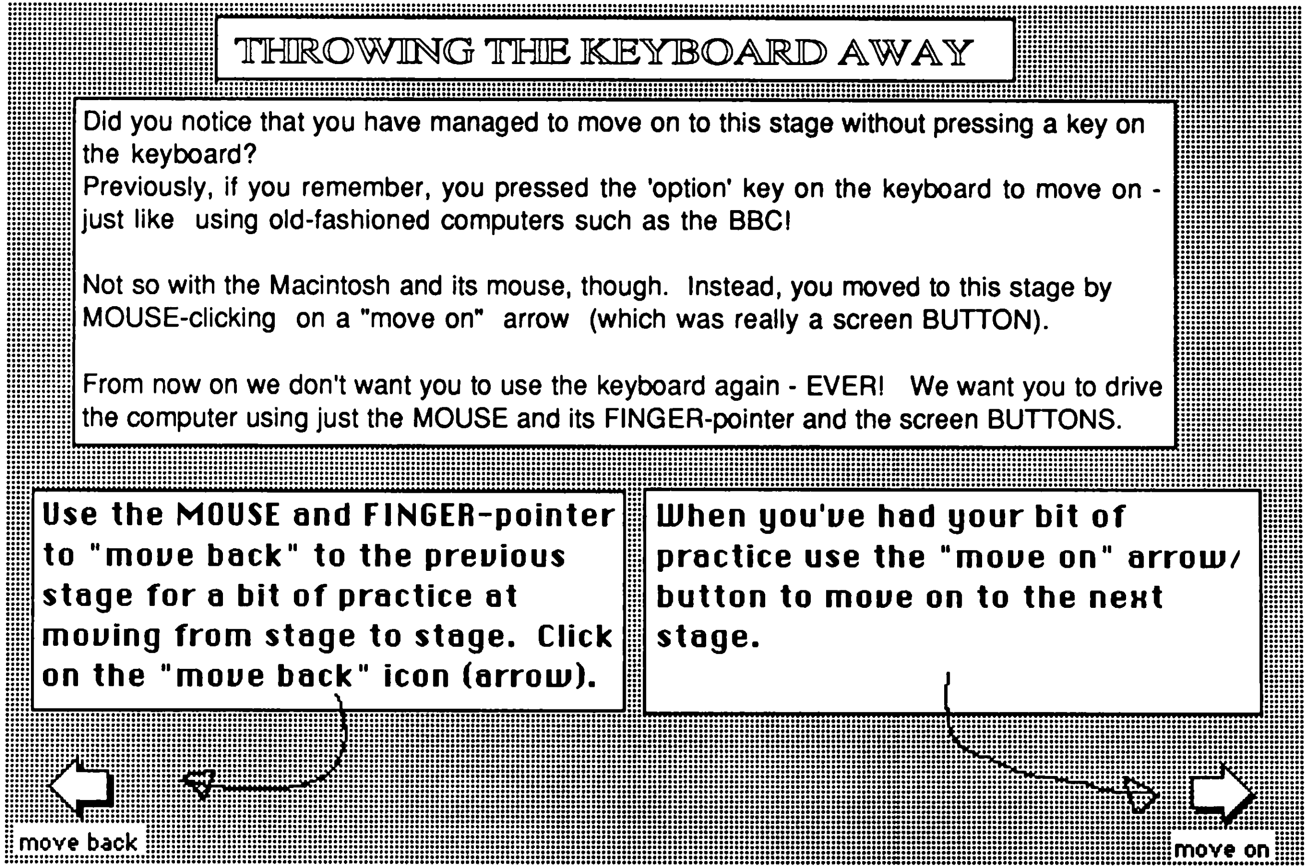
try it!

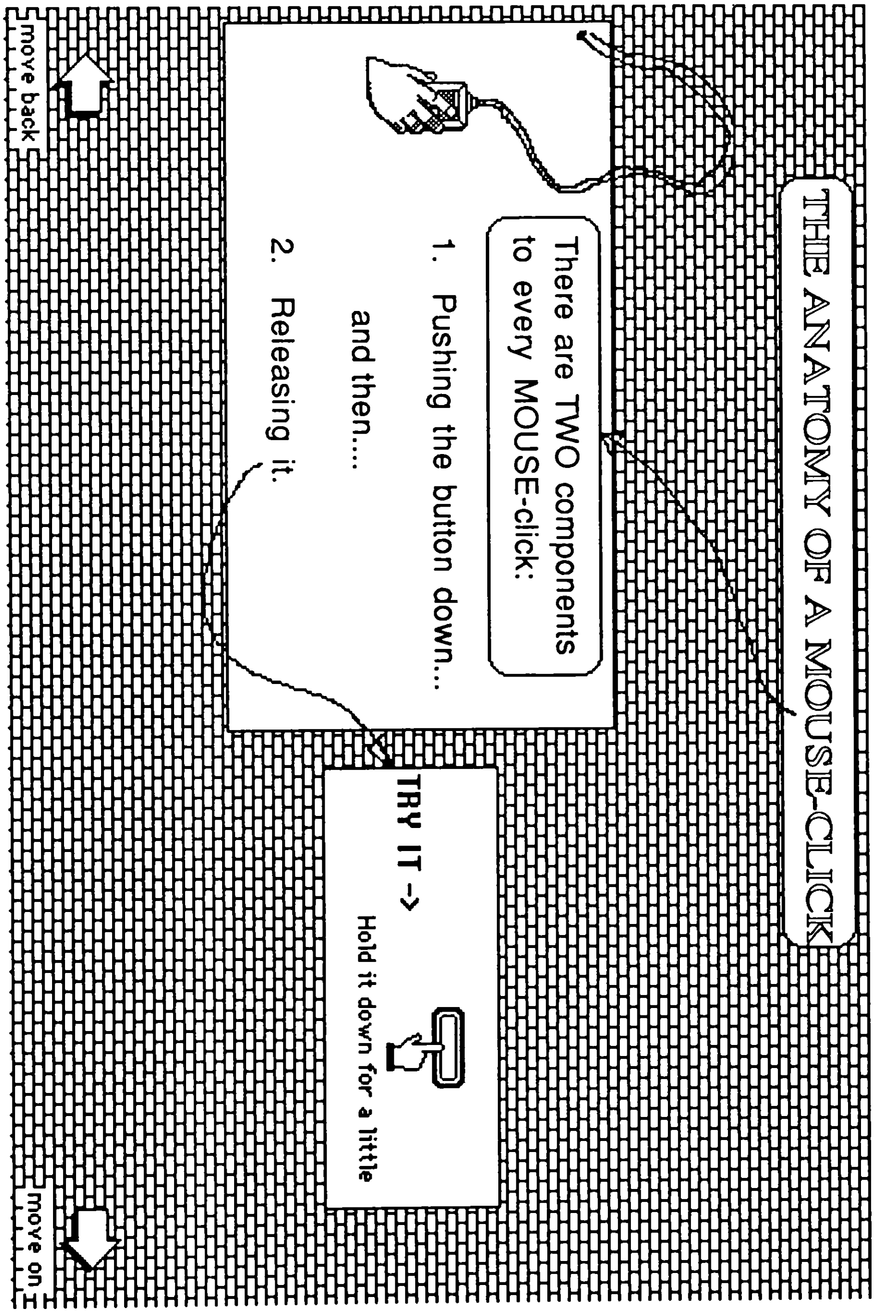
When you replace the MOUSE on the table-top and push it around, you can move the FINGER-pointer around the screen again.

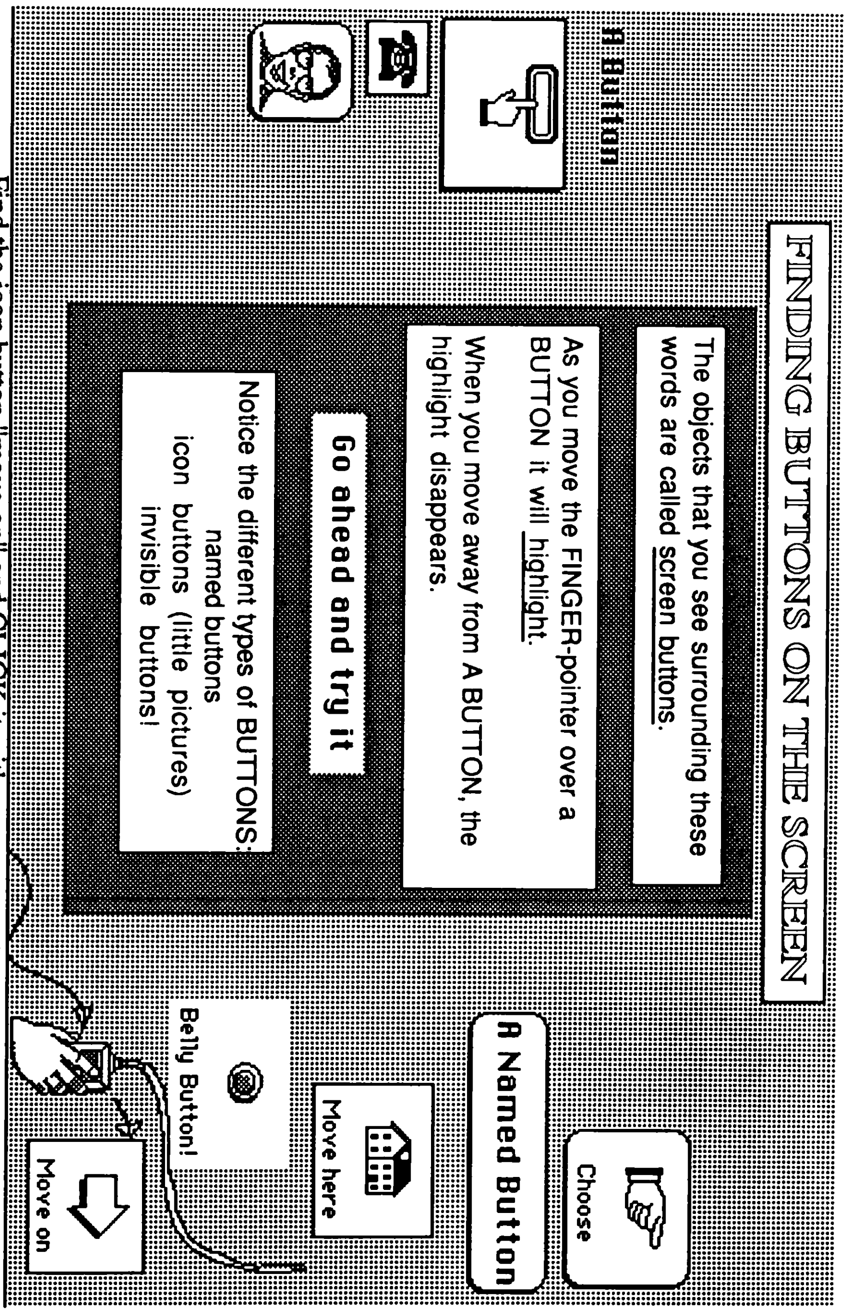
Now let's see you practise.
Move the FINGER-pointer right into each of the 4 corners of the screen.
See how they highlight?

If you are unable at any time to move the mouse far enough over on the table to allow you to position the Finger-pointer on the screen. Simply lift the mouse over on the table and start again.

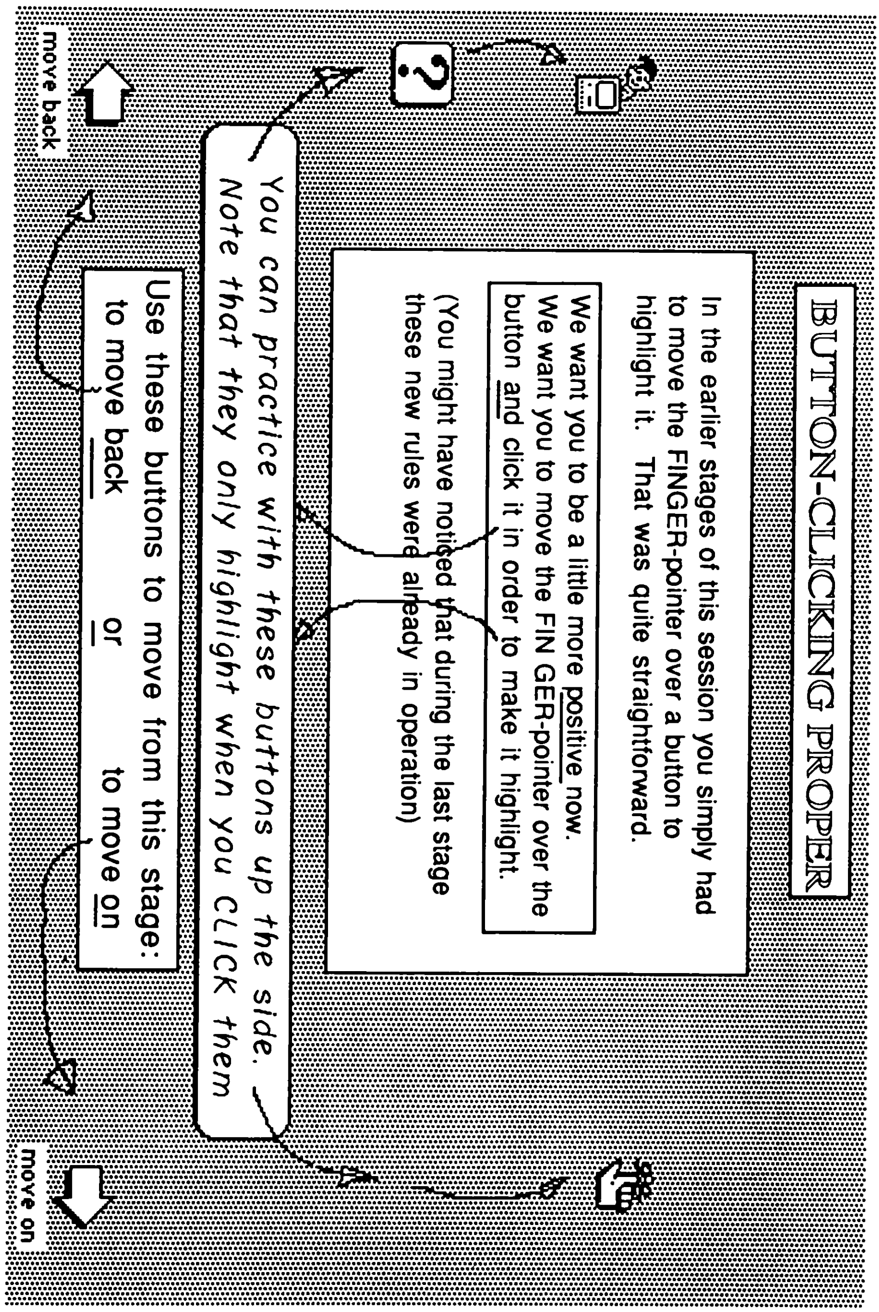
When you get fed up doing this, push the finger-pointer over the highlighted area at the bottom right hand corner of the screen and click the dark gray rectangular button on top of your MOUSE.

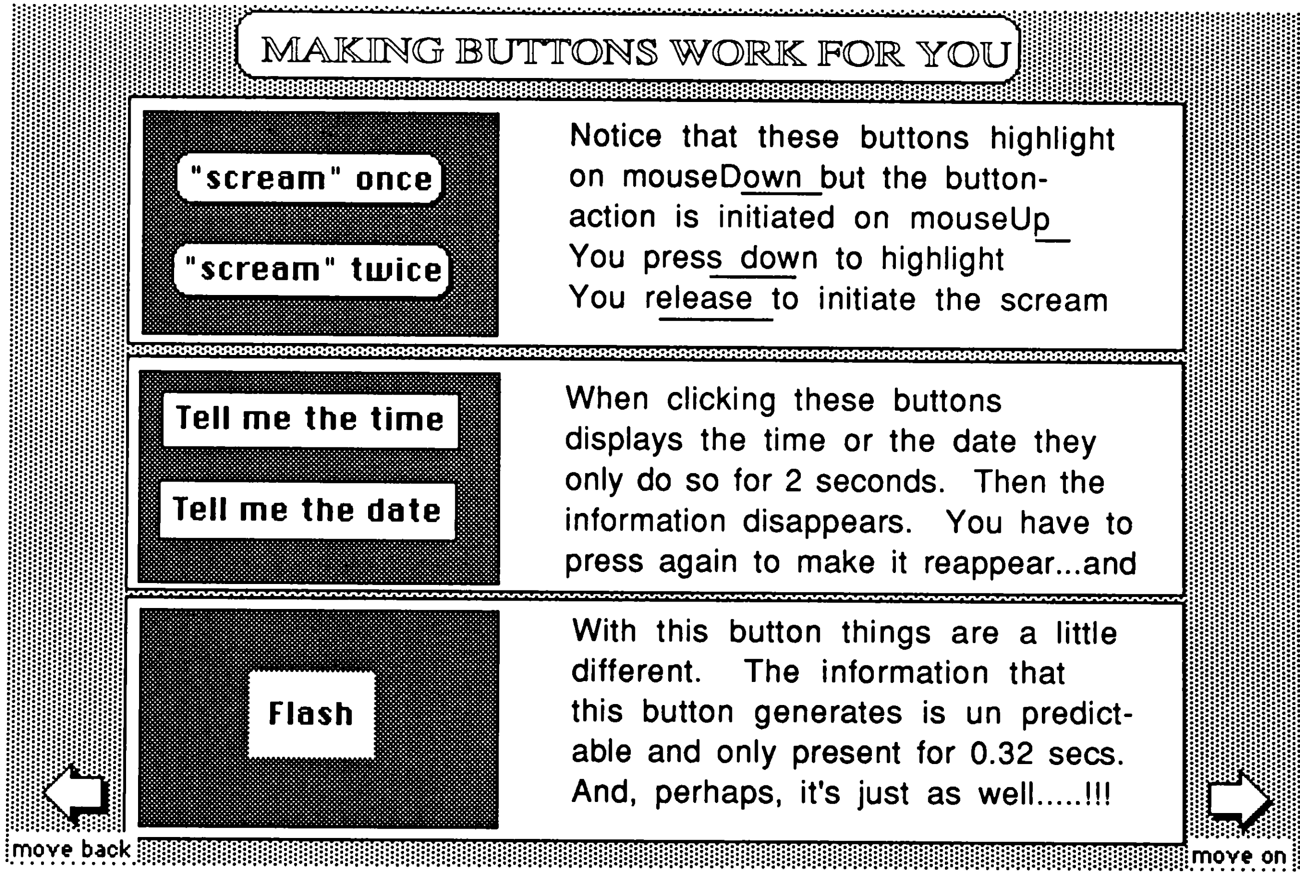

THROWING THE KEYBOARD AWAY
Did you notice that you have managed to move on to this stage without pressing a key on the keyboard?
Previously, if you remember, you pressed the 'option' key on the keyboard to move on - just like using old-fashioned computers such as the BBC!
Not so with the Macintosh and its mouse, though. Instead, you moved to this stage by MOUSE-clicking on a "move on" arrow (which was really a screen BUTTON).
From now on we don't want you to use the keyboard again - EVER! We want you to drive the computer using just the MOUSE and its FINGER-pointer and the screen BUTTONS.
Use the MOUSE and FINGER-pointer to "move back" to the previous stage for a bit of practice at moving from stage to stage. Click on the "move back" icon (arrow).
When you've had your bit of practice use the "move on" arrow/ button to move on to the next stage.
move back
move on

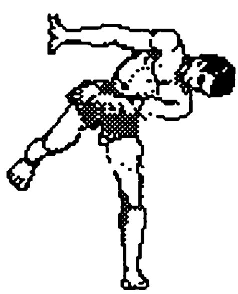

THE ANATOMY OF A MOUSE-CLICK
There are TWO components to every MOUSE-click:
1. Pushing the button down...
and then....
2. Releasing it.
TRY IT ->
Hold it down for a little
move back
move on

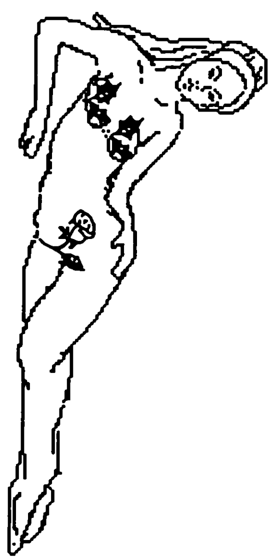


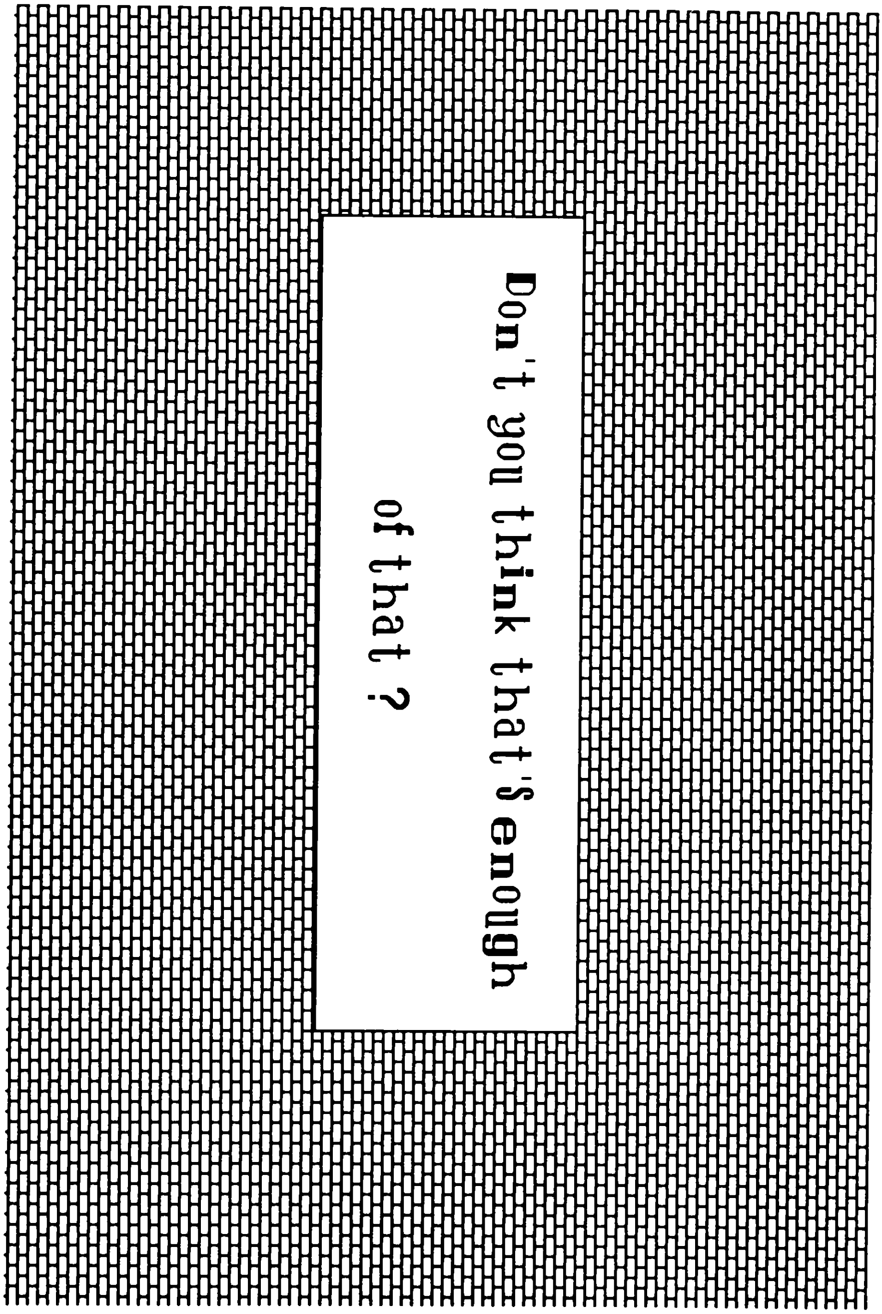
Find the icon button "move on" and CLICK it with your mouse to move on


BUTTON-CLICKING PROPER
In the earlier stages of this session you simply had to move the FINGER-pointer over a button to highlight it. That was quite straightforward.
We want you to be a little more positive now.
We want you to move the FIN GER-pointer over the button and click it in order to make it highlight.
(You might have noticed that during the last stage these new rules were already in operation)
You can practice with these buttons up the side.
Note that they only highlight when you CLICK them
Use these buttons to move from this stage:
to move back or to move on
move back
move on


MAKING BUTTONS WORK FOR YOU
"scream" once
"scream" twice
Notice that these buttons highlight on mouseDown but the button-action is initiated on mouseUp
You press down to highlight
You release to initiate the scream
Tell me the time
Tell me the date
When clicking these buttons displays the time or the date they only do so for 2 seconds. Then the information disappears. You have to press again to make it reappear...and
Flash
With this button things are a little different. The information that this button generates is un predict-able and only present for 0.32 secs. And, perhaps, it's just as well.....!!!
move back
move on






Don't you think that's enough
of that ?

REMEMBER THE GAME WE MENTIONED EARLIER?

We want you to play a little game which should help you learn to handle the mouse a little more quickly.

When you move on you'll see 10 button-icons (all Macintosh computers, in fact!) arranged in a loose circle around a button labelled "START".

When you're ready, press the START button - One by one they will each highlight and each one will remain highlighted until you move the Finger-Pointer to it and de-highlight it by mouse-clicking (down and up) on top.

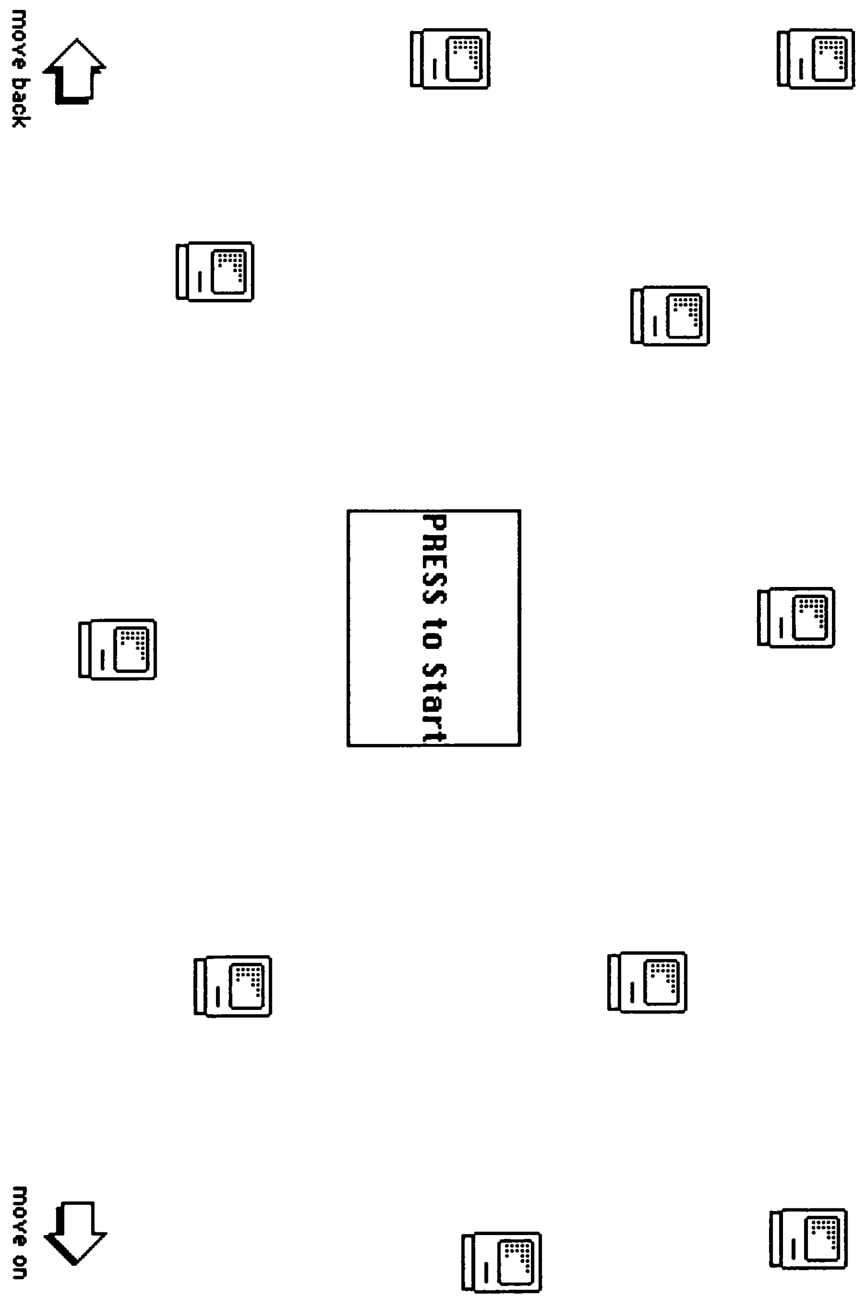
When you've dealt with all 10 of them you'll hear a "beep" and the speed with which you have carried out the complete task will be displayed.

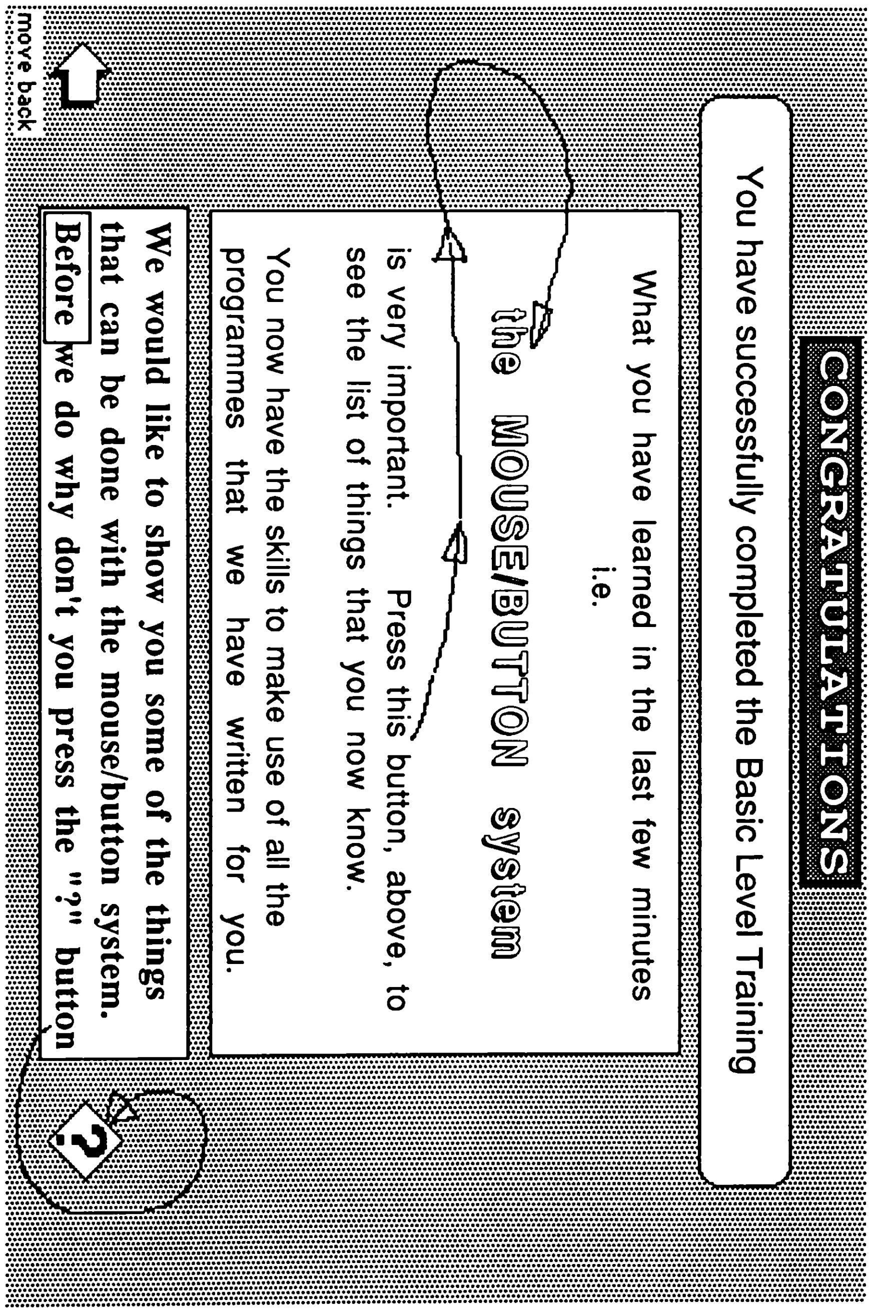
No more instructions. Just try it to see how quick you are! If you get a lousy time (23 secs is v. good) simply press START and have another go.

move back

o.k. so on with the game

move on


move back
PRESS to Start
move on


CONGRATULATIONS
You have successfully completed the Basic Level Training
What you have learned in the last few minutes
i.e.
the MOUSE/BUTTON system
is very important. Press this button, above, to see the list of things that you now know.
You now have the skills to make use of all the programmes that we have written for you.
We would like to show you some of the things that can be done with the mouse/button system.
Before we do why don't you press the "?" button
?
move back

A break for coffee, perhaps ?

Even if you don't want to break for coffee, it is worth reading this:

We're going to give you a HOMEBASE where you can go to whenever you want a rest.

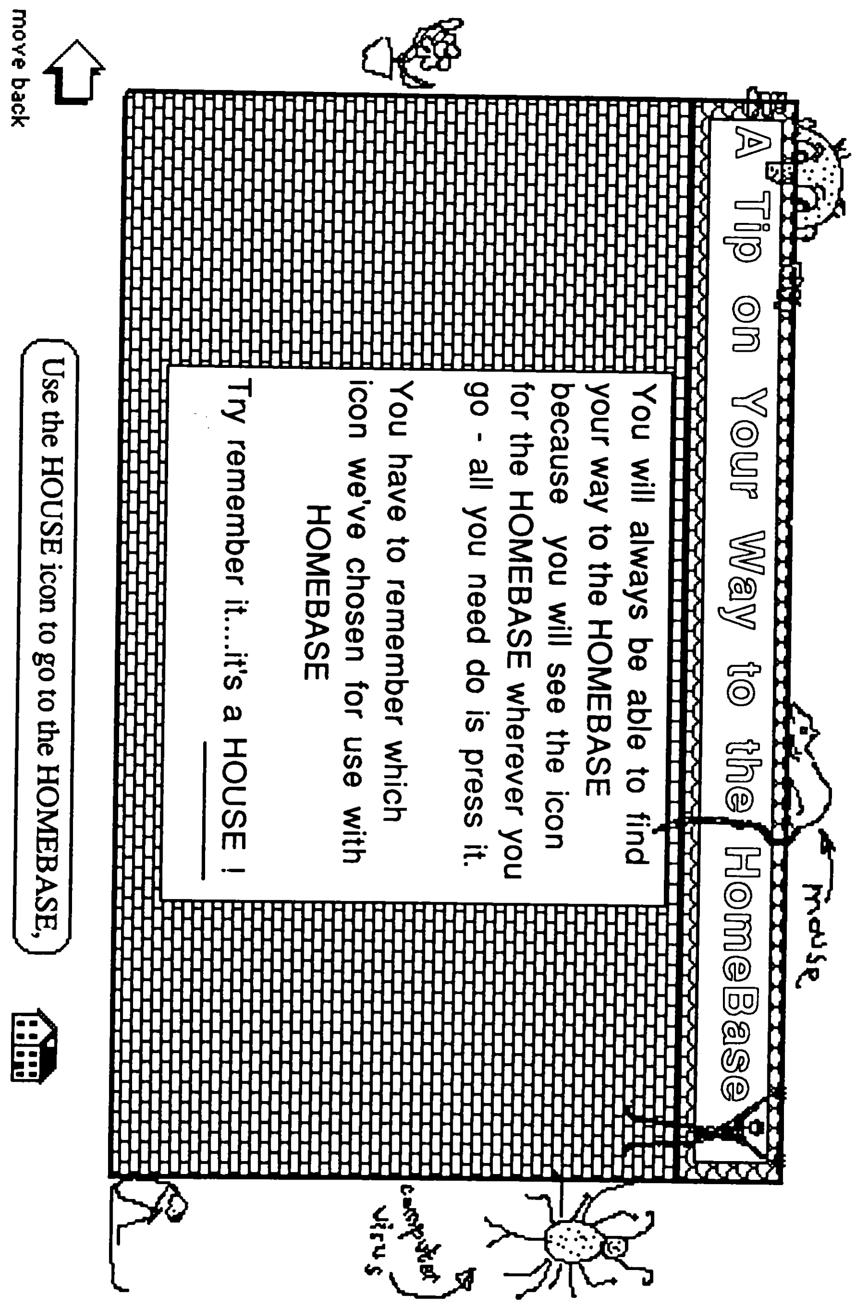
It is a useful place to know about.

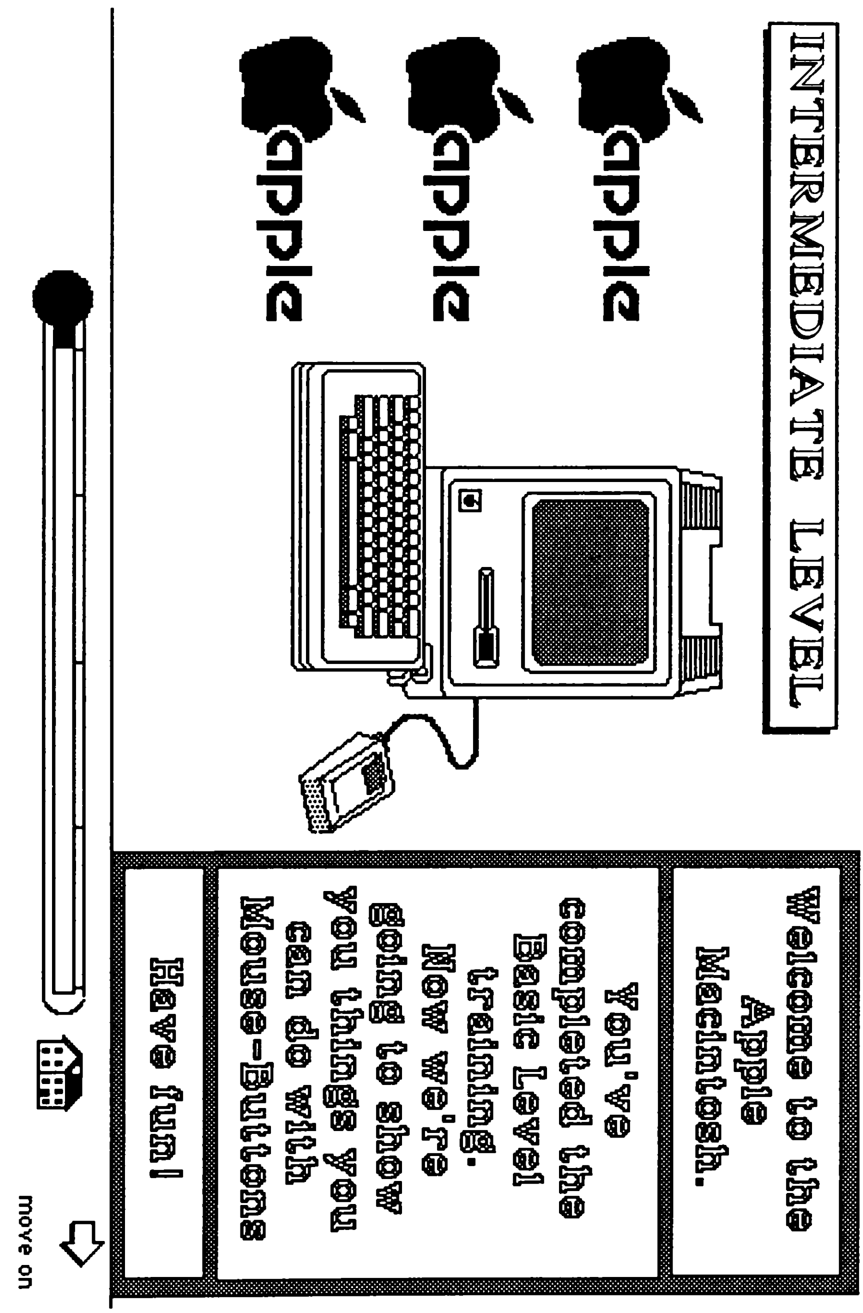
From HOMEBASE you can go anywhere you want!

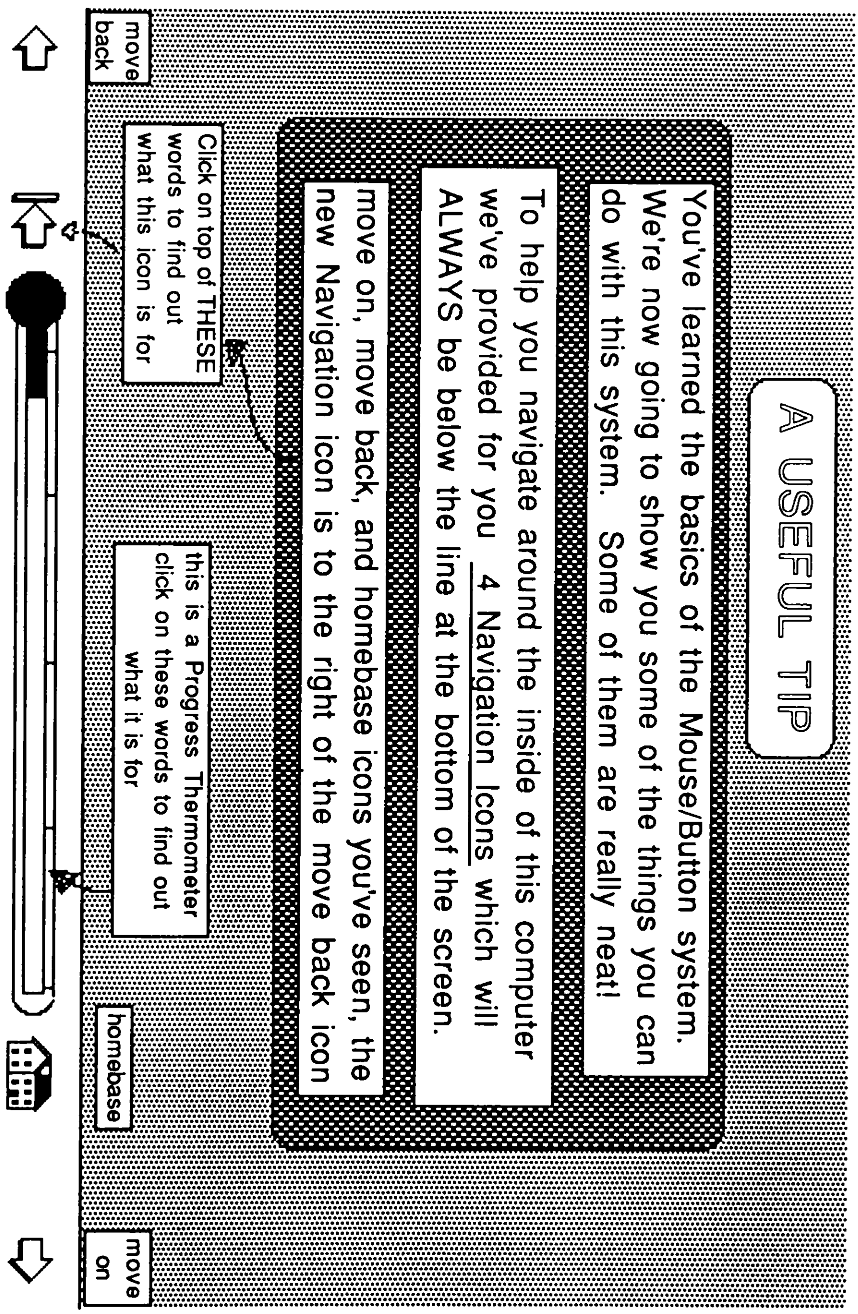
You can go to any of the programmes we've written.....you can go for a coffee...you can have a rest....you can do almost anything!
And, of course, from there you can quit and go to your real home.

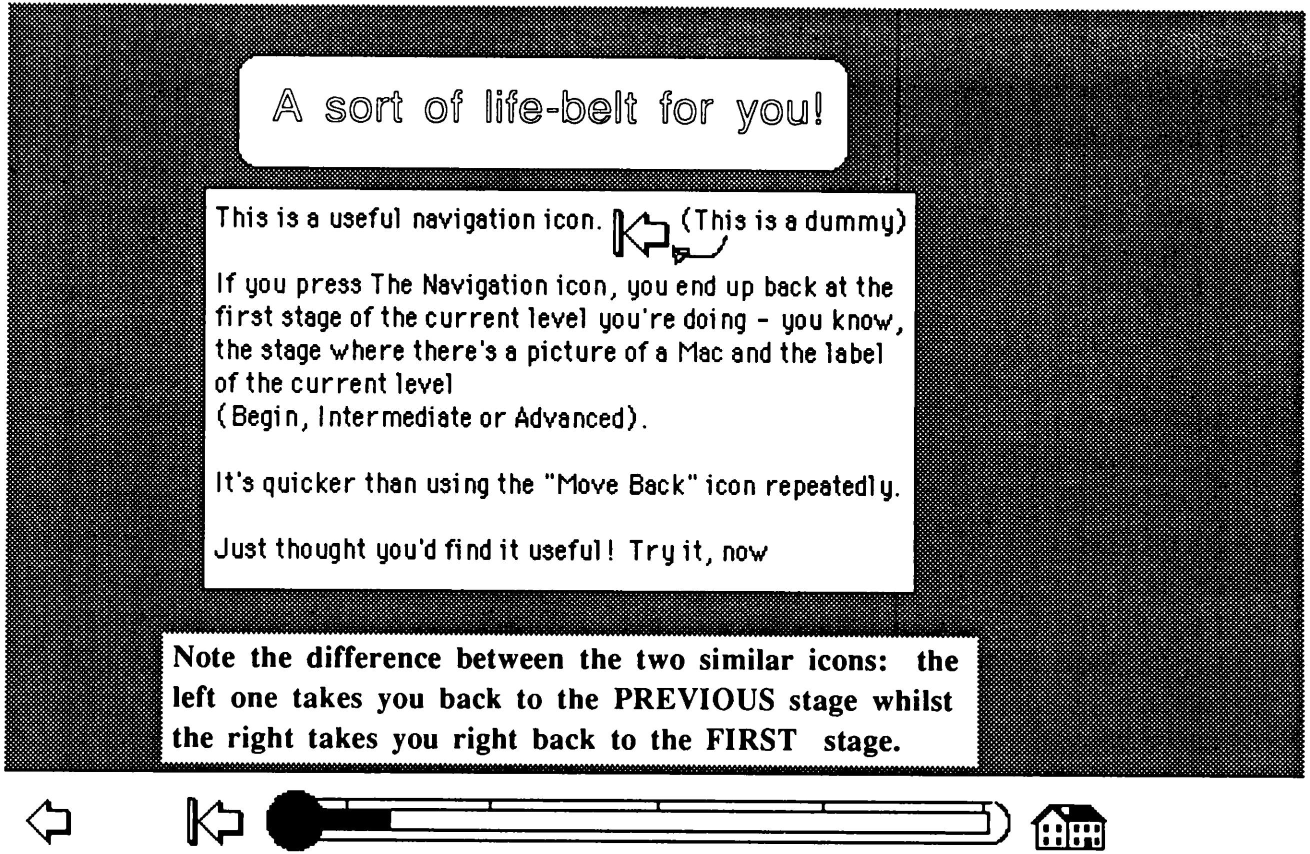
Click the coffee cups to get there

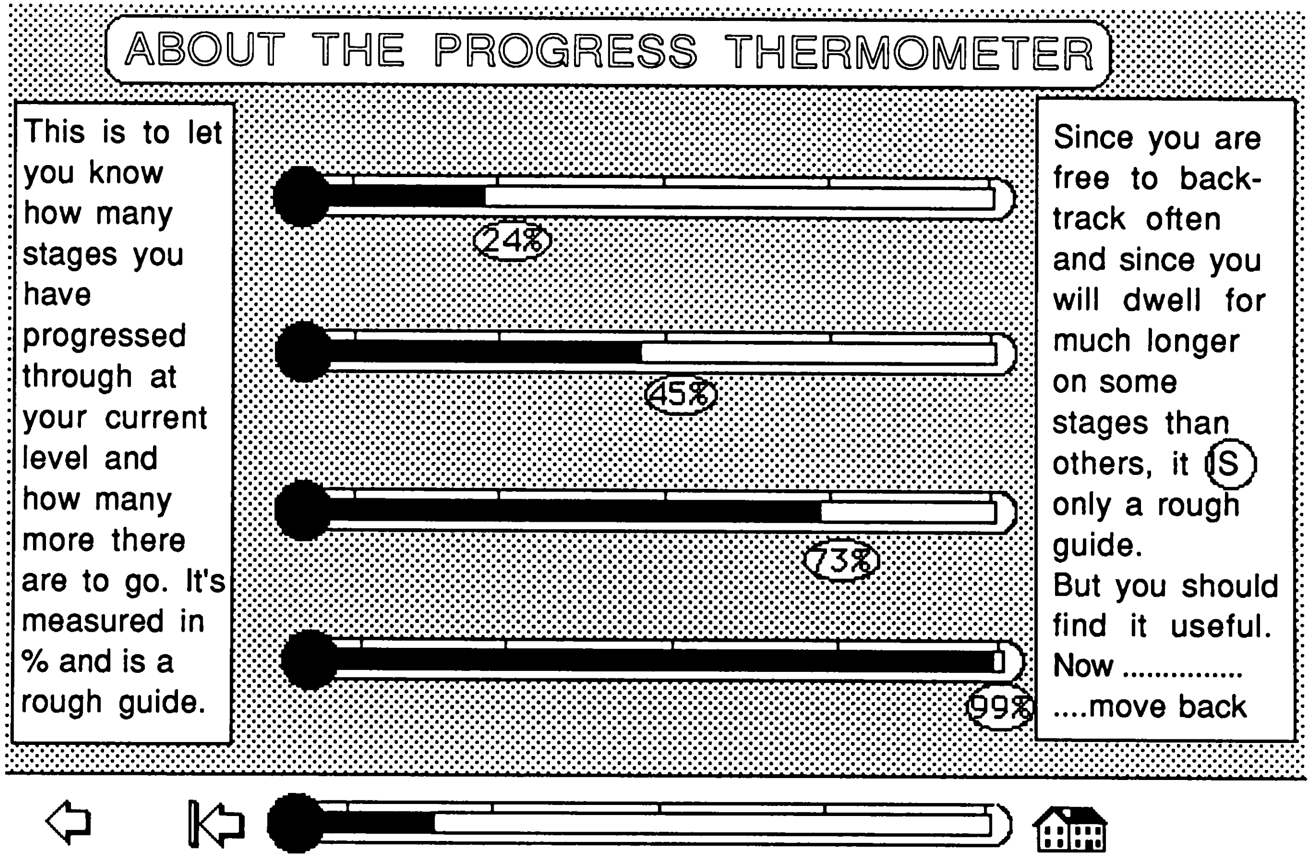
move back

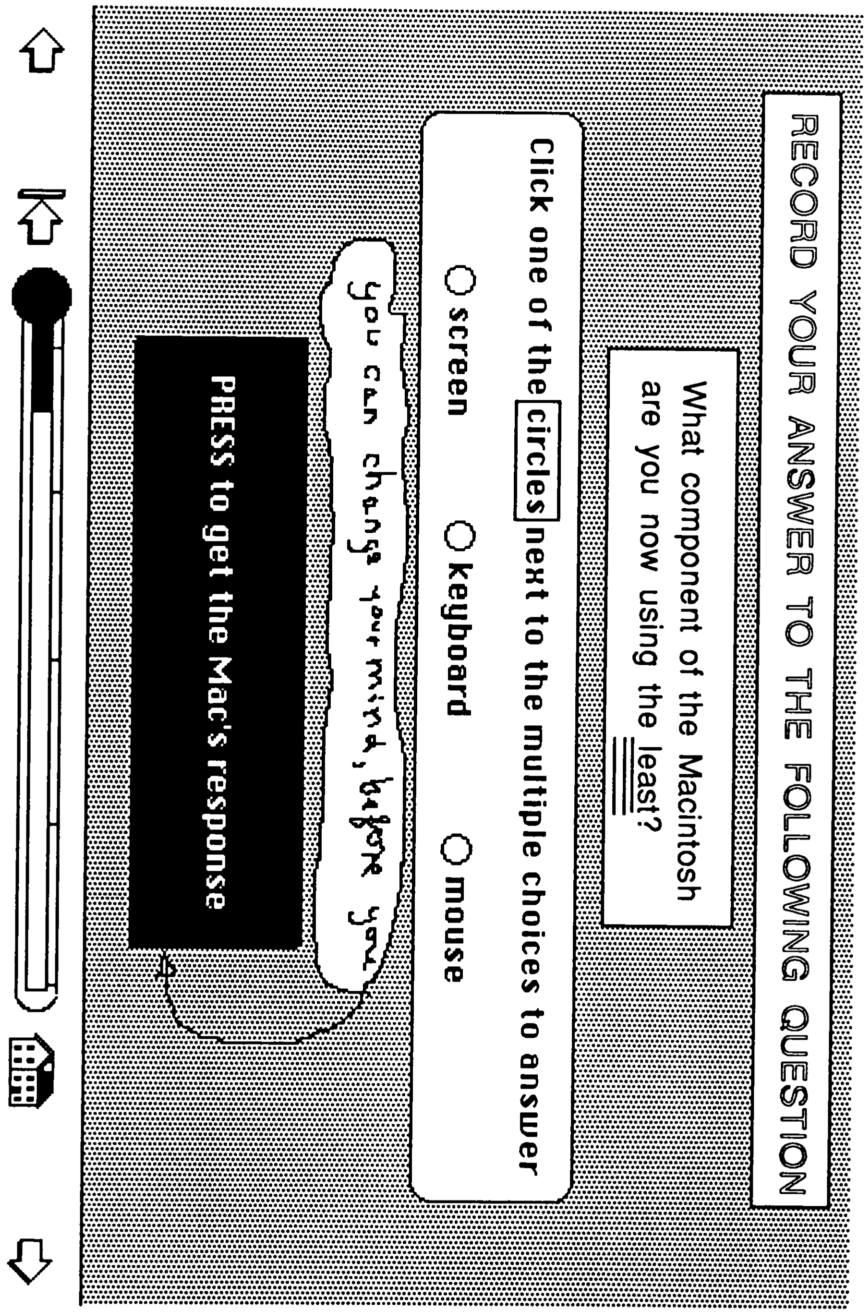

A Tip on Your Way to the HomeBase
You will always be able to find your way to the HOMEBASE because you will see the icon for the HOMEBASE wherever you go - all you need do is press it.
You have to remember which icon we've chosen for use with HOMEBASE
Try remember it....it's a HOUSE !
mouse
computer virus
move back
Use the HOUSE icon to go to the HOMEBASE,

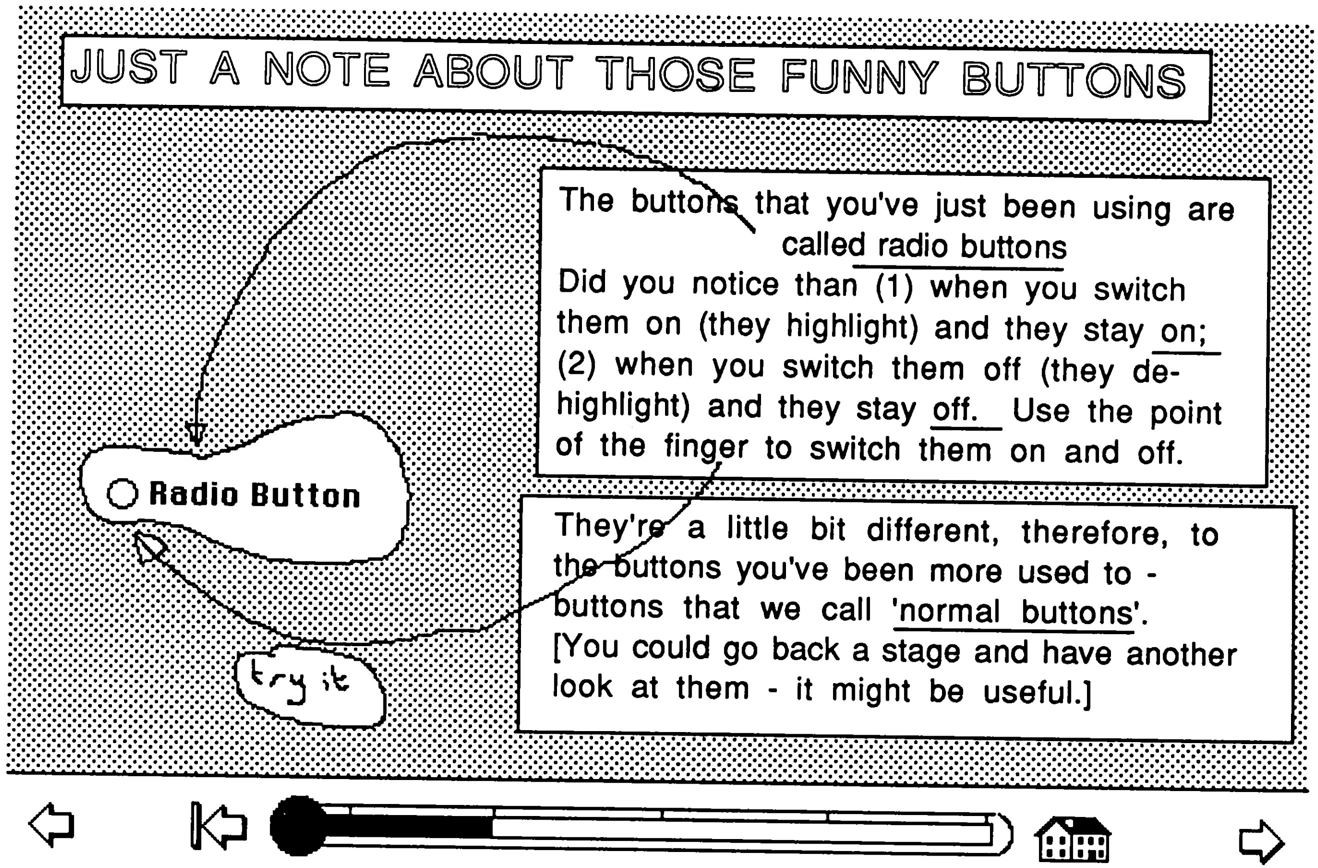

INTERMEDIATE LEVEL
apple
apple
apple
Welcome to the Apple Macintosh.
You've completed the Basic Level training. Now we're going to show you things you can do with Mouse-Buttons
Have fun!
move on

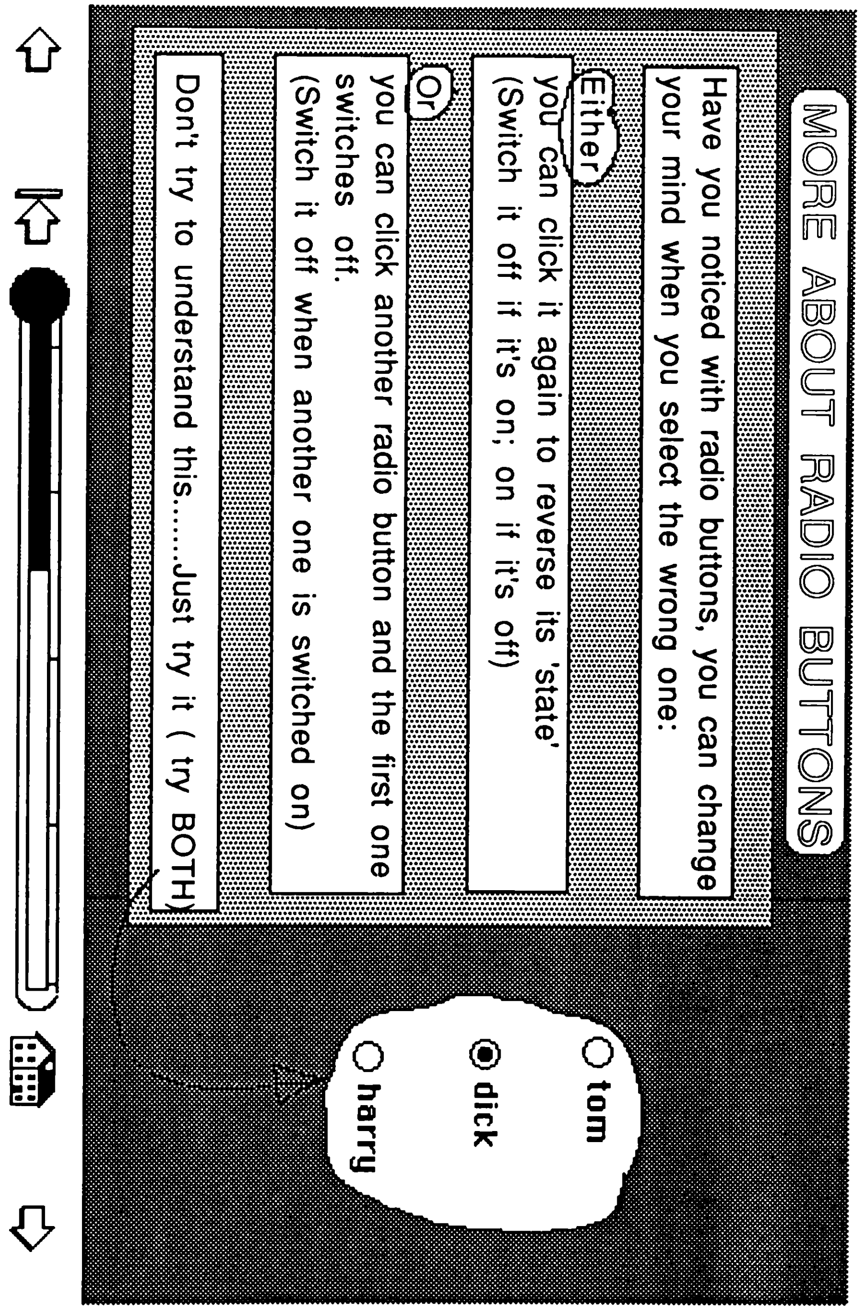

A USEFUL TIP
You've learned the basics of the Mouse/Button system. We're now going to show you some of the things you can do with this system. Some of them are really neat!
To help you navigate around the inside of this computer we've provided for you 4 Navigation Icons which will ALWAYS be below the line at the bottom of the screen.
move on, move back, and homebase icons you've seen, the new Navigation icon is to the right of the move back icon
Click on top of THESE words to find out what this icon is for
this is a Progress Thermometer click on these words to find out what it is for
move back
homebase
move on

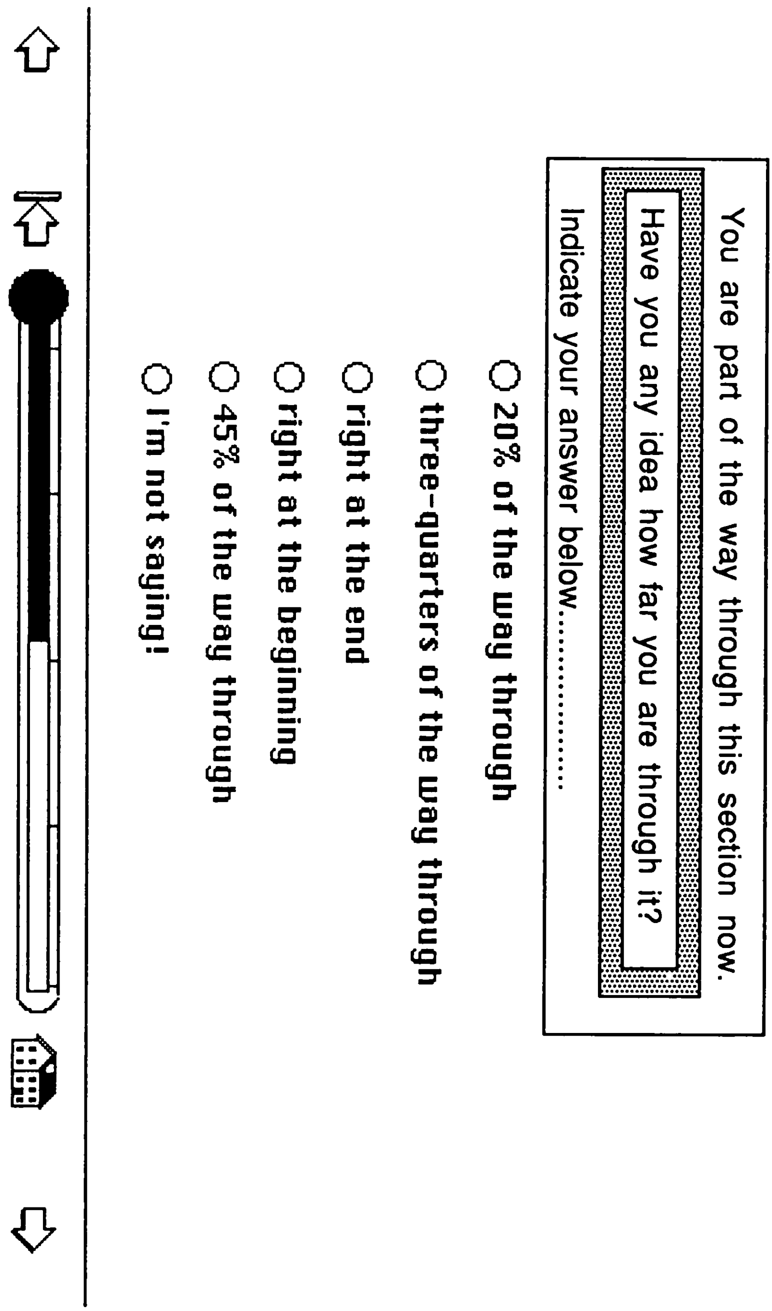

A sort of life-belt for you!
This is a useful navigation icon. (This is a dummy)
If you press The Navigation icon, you end up back at the first stage of the current level you're doing - you know, the stage where there's a picture of a Mac and the label of the current level
(Begin, Intermediate or Advanced).
It's quicker than using the "Move Back" icon repeatedly.
Just thought you'd find it useful! Try it, now
Note the difference between the two similar icons: the left one takes you back to the PREVIOUS stage whilst the right takes you right back to the FIRST stage.

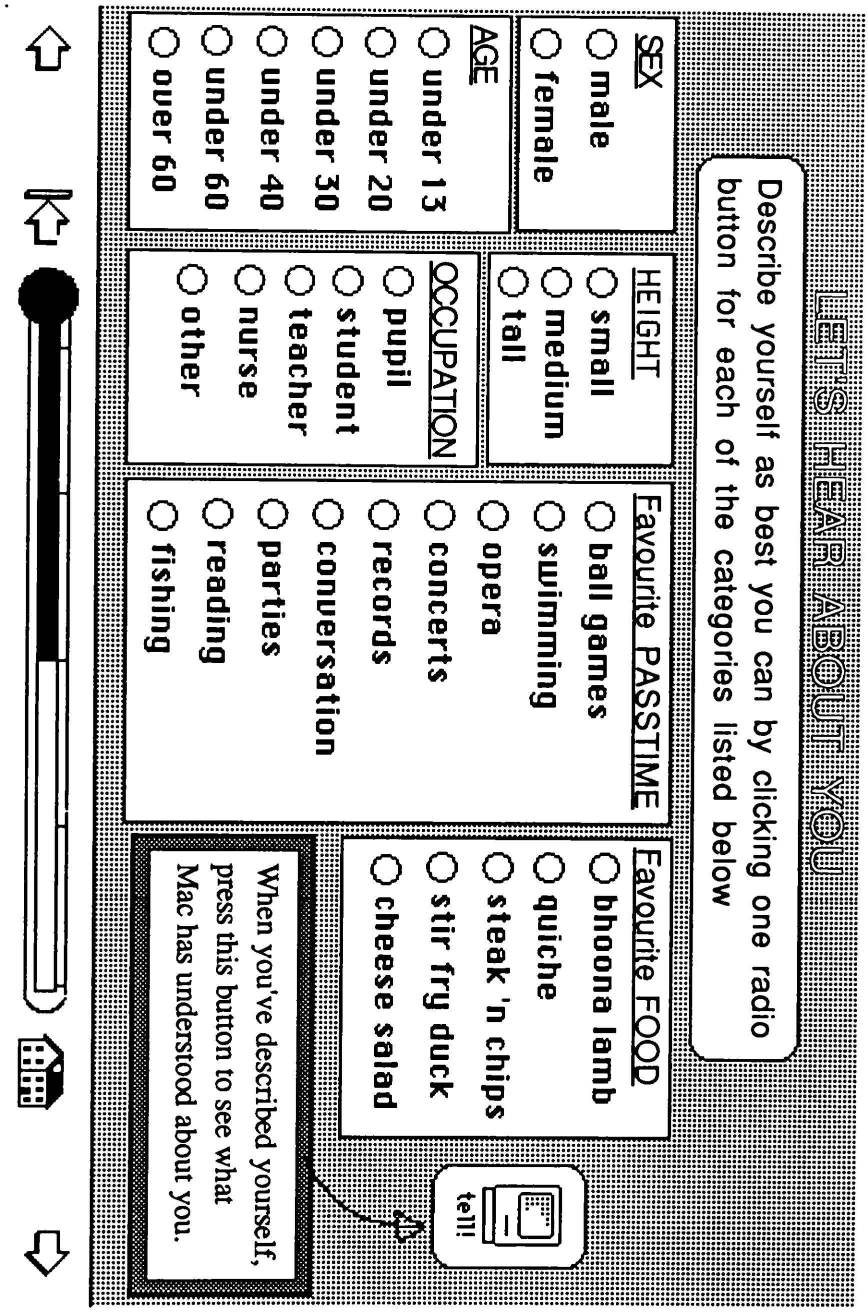

ABOUT THE PROGRESS THERMOMETER
This is to let you know how many stages you have progressed through at your current level and how many more there are to go. It's measured in % and is a rough guide.
24%
45%
73%
99%
Since you are free to back-track often and since you will dwell for much longer on some stages than others, it IS only a rough guide.
But you should find it useful.
Now ....
....move back

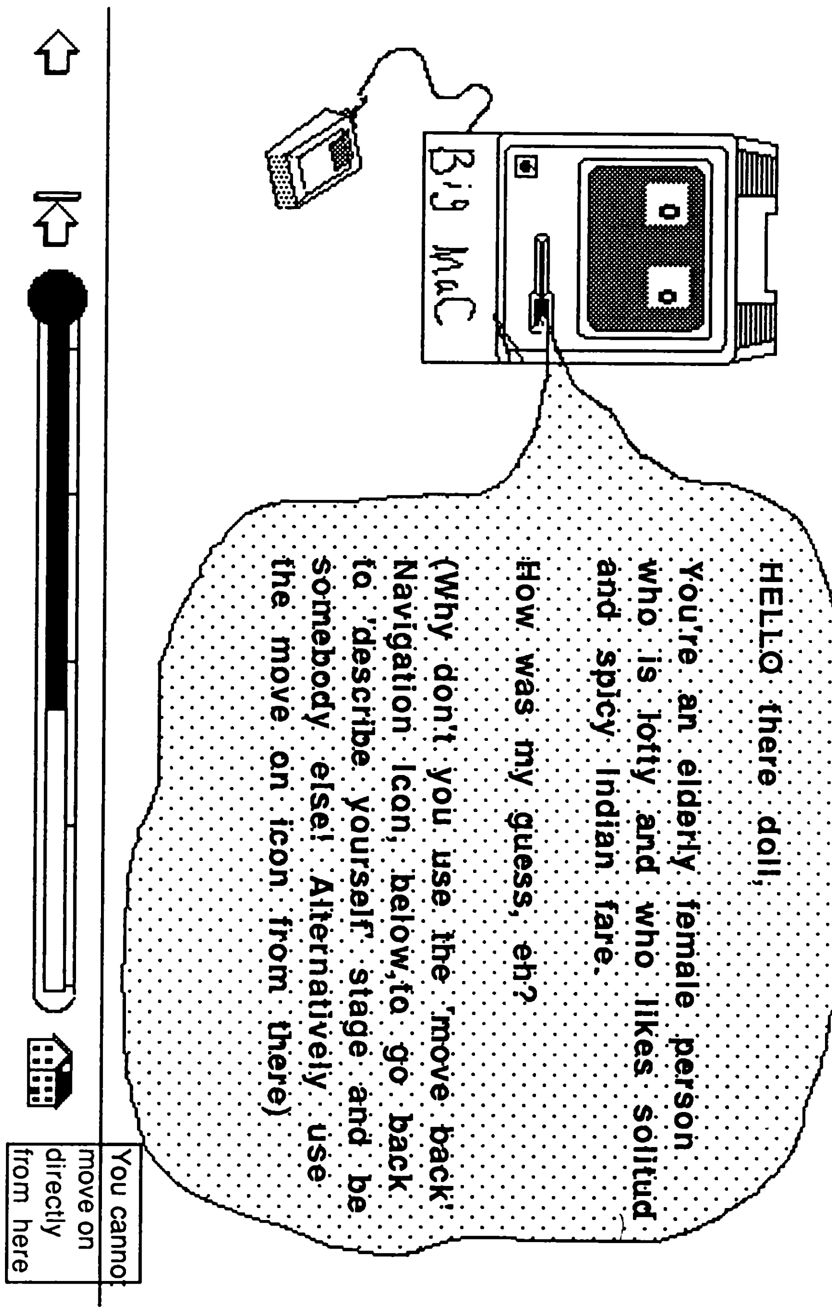

RECORD YOUR ANSWER TO THE FOLLOWING QUESTION
What component of the Macintosh are you now using the least?
Click one of the circles next to the multiple choices to answer
screen
keyboard
mouse
you can change your mind, before you
PRESS to get the Mac's response


JUST A NOTE ABOUT THOSE FUNNY BUTTONS
Radio Button
try it
The buttons that you've just been using are called radio buttons
Did you notice than (1) when you switch them on (they highlight) and they stay on; (2) when you switch them off (they de-highlight) and they stay off. Use the point of the finger to switch them on and off.
They're a little bit different, therefore, to the buttons you've been more used to - buttons that we call 'normal buttons'.
[You could go back a stage and have another look at them - it might be useful.]


MORE ABOUT RADIO BUTTONS
Have you noticed with radio buttons, you can change your mind when you select the wrong one:
Either
you can click it again to reverse its 'state'
(Switch it off if it's on; on if it's off)
Or
you can click another radio button and the first one switches off.
(Switch it off when another one is switched on)
Don't try to understand this......Just try it (try BOTH)
tom
dick
harry


You are part of the way through this section now.
Have you any idea how far you are through it?
Indicate your answer below...............
20% of the way through
three-quarters of the way through
right at the end
right at the beginning
45% of the way through
I'm not saying!


LET'S HEAR ABOUT YOU
Describe yourself as best you can by clicking one radio button for each of the categories listed below
SEX
male
female
AGE
under 13
under 20
under 30
under 40
under 60
over 60
HEIGHT
small
medium
tall
OCCUPATION
pupil
student
teacher
nurse
other
Favourite PASSTIME
ball games
swimming
opera
concerts
records
conversation
parties
reading
fishing
Favourite FOOD
bhoona lamb
quiche
steak 'n chips
stir fry duck
cheese salad
tell!
When you've described yourself, press this button to see what Mac has understood about you.


Big MaC
HELLO there doll,
You're an elderly female person who is lofty and who likes solitud and spicy Indian fare.
How was my guess, eh?
(Why don't you use the 'move back' Navigation Icon, below,to go back to 'describe yourself' stage and be somebody else! Alternatively use the move on icon from there)
You canno move on directly from here

A FINAL NOTE ON THESE FUNNY BUTTONS

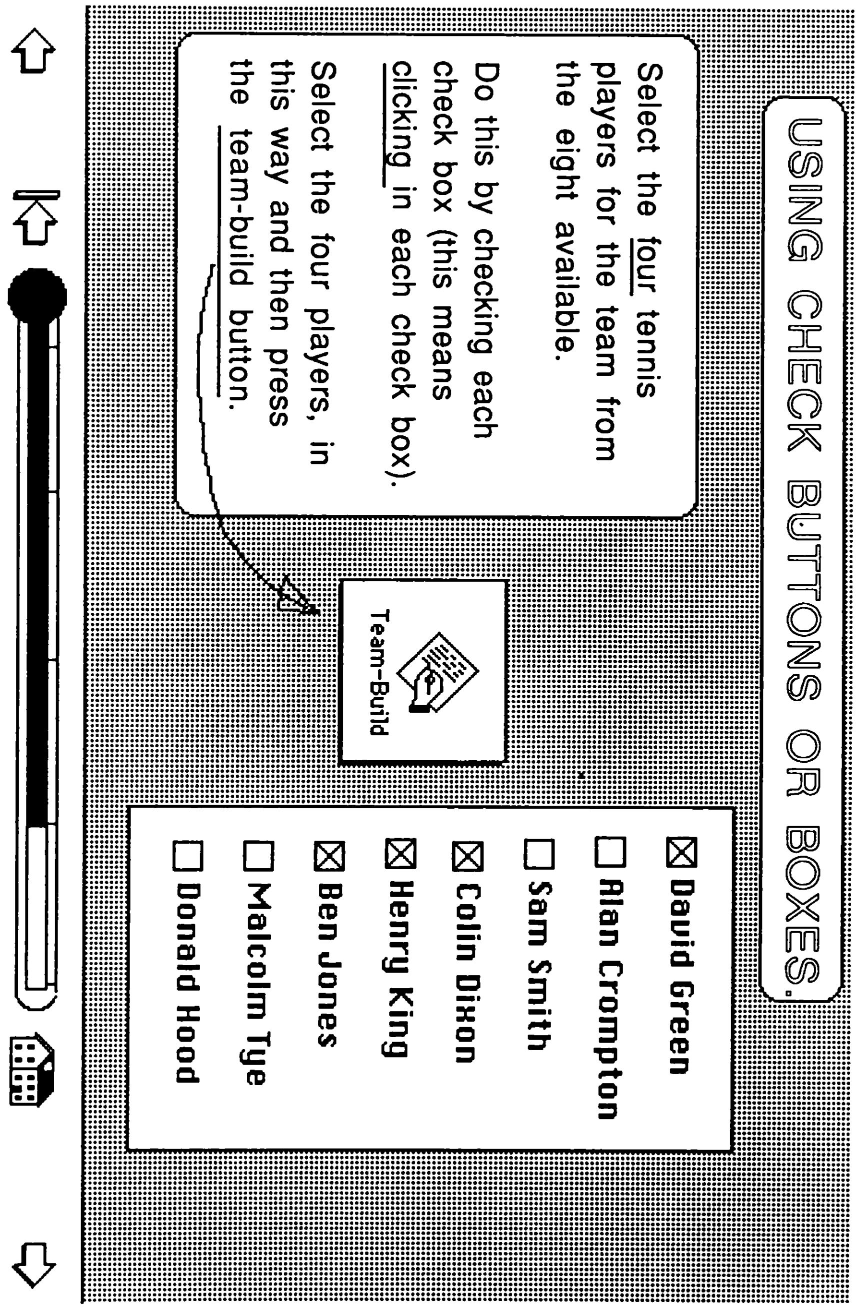
They're usually used when we want you (the user) to select a SINGLE item from a group of items.

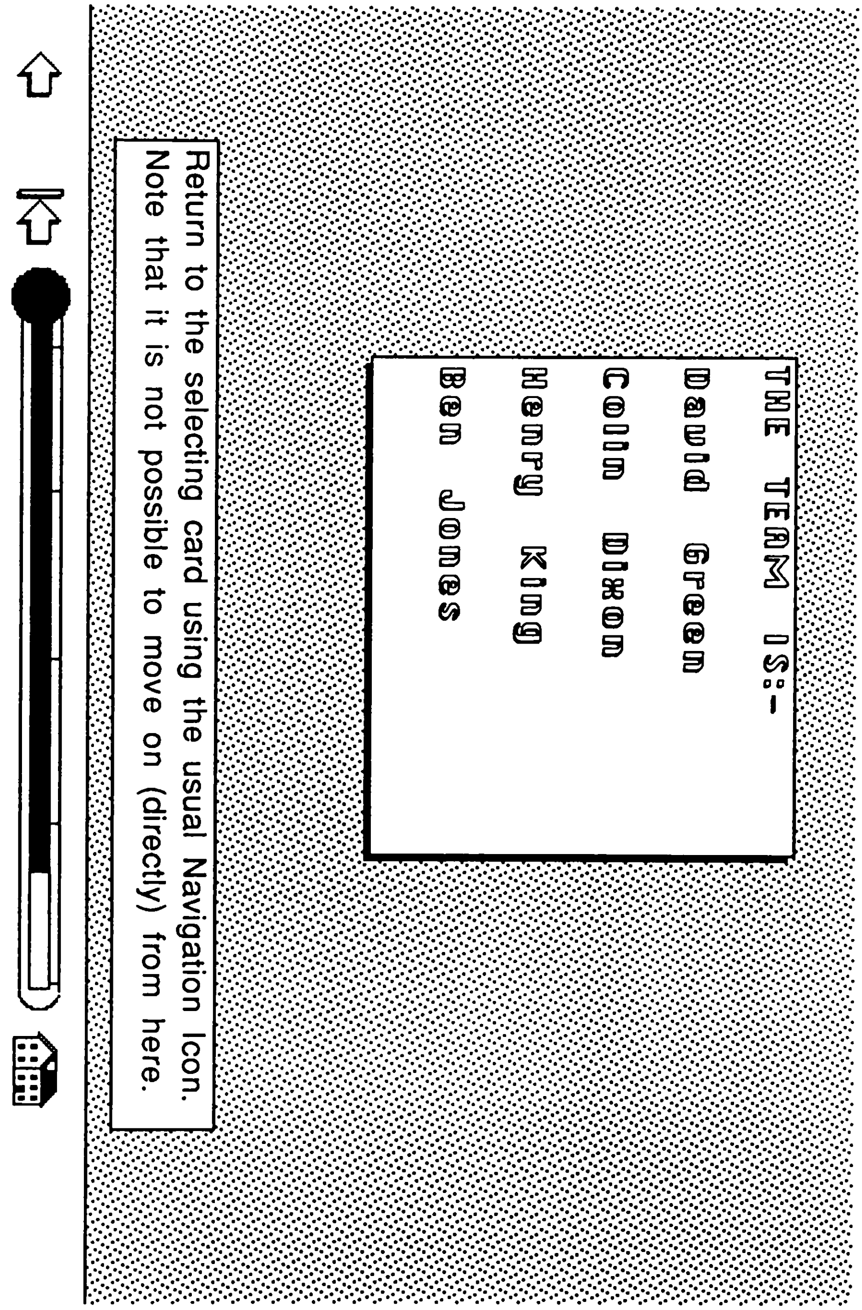
e.g - male OR female from the group 'sex'.
- tall, medium OR short from the group 'height'.

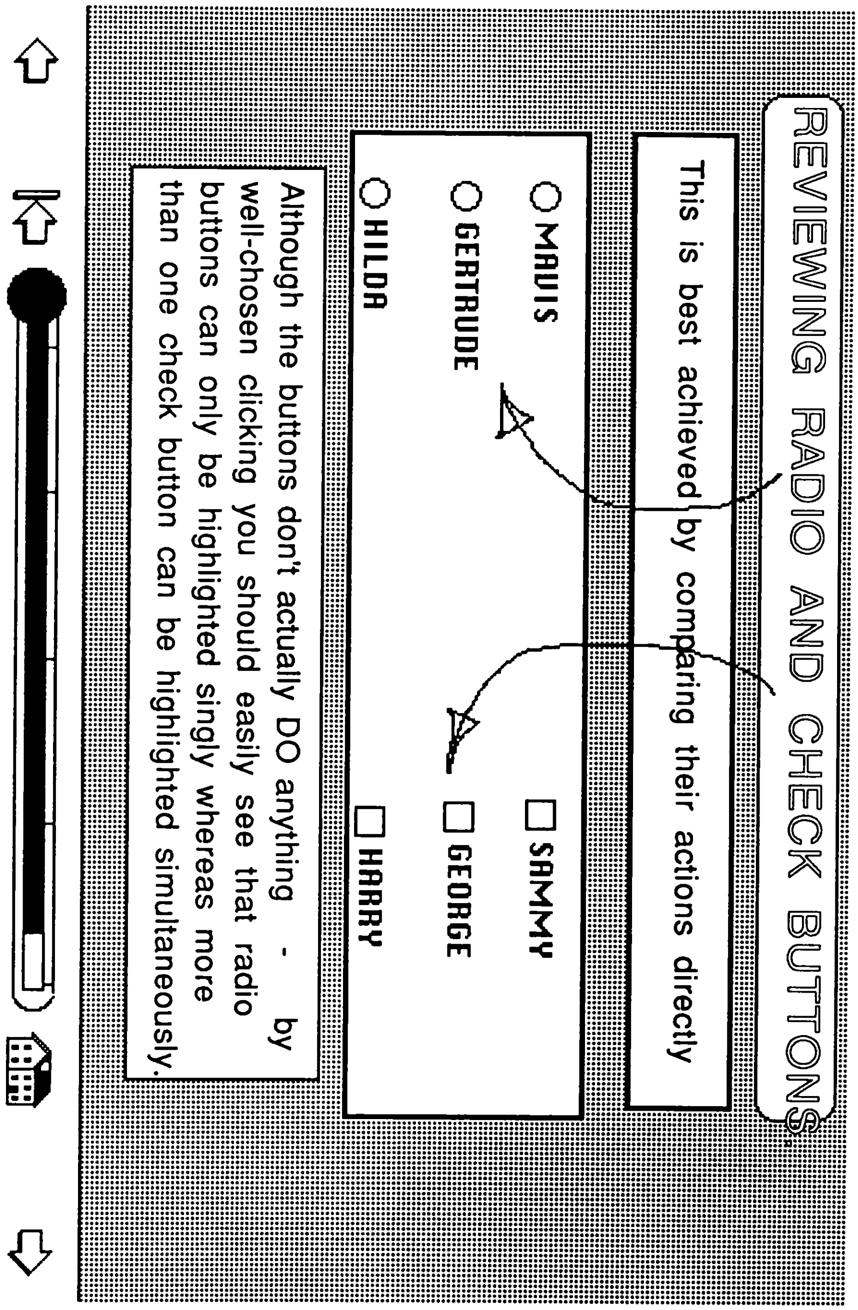
As you've seen, this is a frequent use for RADIO buttons

Sometimes (frequently, in fact) there is a different requirement, though.
Sometimes we might want you to select MORE than one item from within a group.

In this case we use CHECK buttons. Move on to look at them.


USING CHECK BUTTONS OR BOXES.
Select the four tennis players for the team from the eight available.
Do this by checking each check box (this means clicking in each check box).
Select the four players, in this way and then press the team-build button.
Team-Build
David Green
Alan Crompton
Sam Smith
Colin Dixon
Henry King
Ben Jones
Malcolm Tye
Donald Hood


THE TEAM IS:-
David Green
Colin Dixon
Henry King
Ben Jones
Return to the selecting card using the usual Navigation Icon.
Note that it is not possible to move on (directly) from here.


REVIEWING RADIO AND CHECK BUTTONS
This is best achieved by comparing their actions directly
MAVIS
GERTRUDE
HILDA
SAMMY
GEORGE
HARRY
Although the buttons don't actually DO anything - by well-chosen clicking you should easily see that radio buttons can only be highlighted singly whereas more than one check button can be highlighted simultaneously.

COMPUTER-USE

SKILLS ->

YOUR ACCOMPLISHMENTS

By now you know how to do the following things:

1. Drive the finger pointer with the mouse.
2. Handle standard buttons.
3. Handle radio buttons.
4. Handle check buttons.

5. Use radio and check buttons to build up descriptions of people, groups etc <u>without using the keyboard.</u>

If you've got this far, then you must be getting quite proficient at using the Mac Well done, keep it up.......go to Homebase!

<- USING

COMPUTER SKILLS

Remember, if you want to get a bit of practice applying the computer-use skills you've acquired in the last ten minutes you could go back to the beginning of the INTERMEDIATE section and quickly whip through all the stages.

Do you remember which icon you should use to get to the beginning of the Intermediate section?

(If you feel you have had more than enough practice, then you can return to the HOMEBASE)

Nursing Process

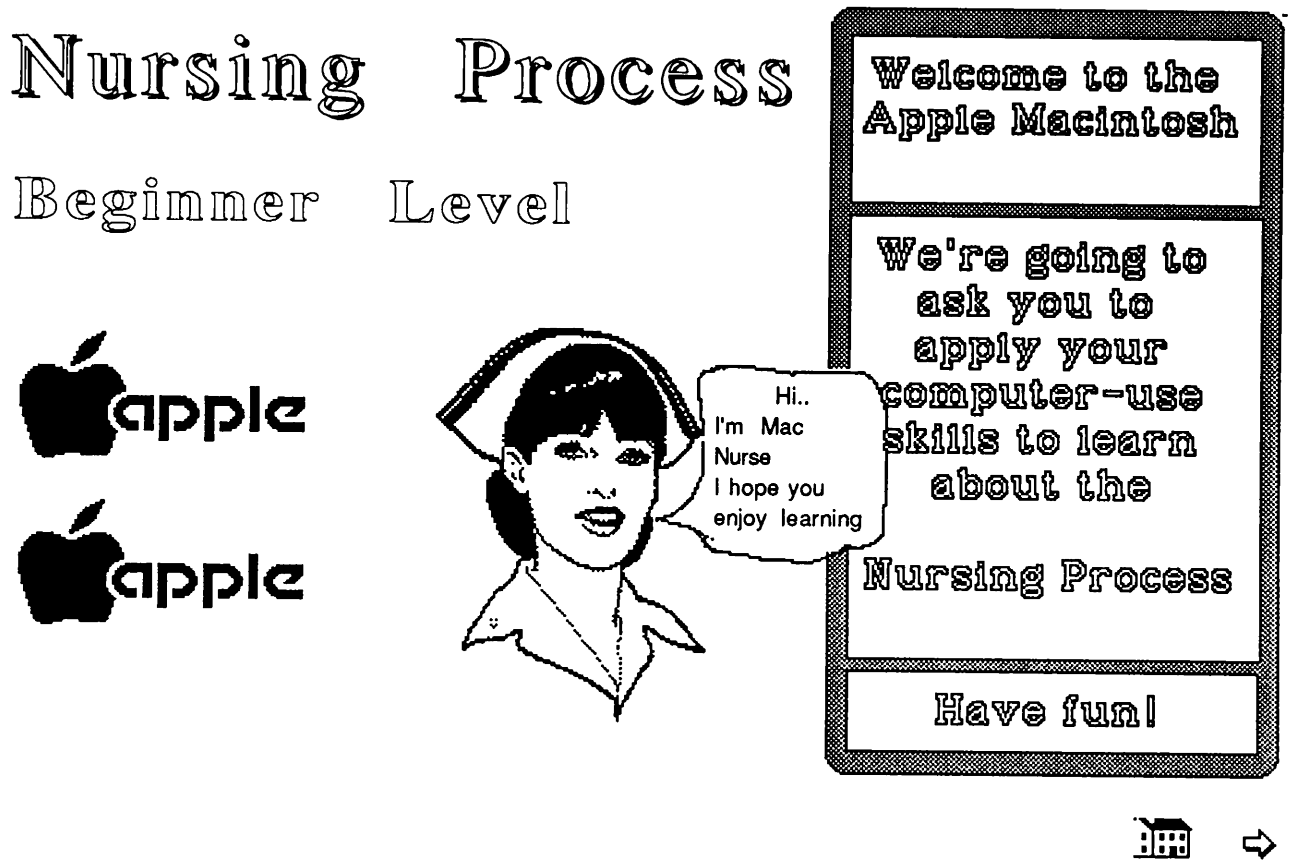
Introductory Level

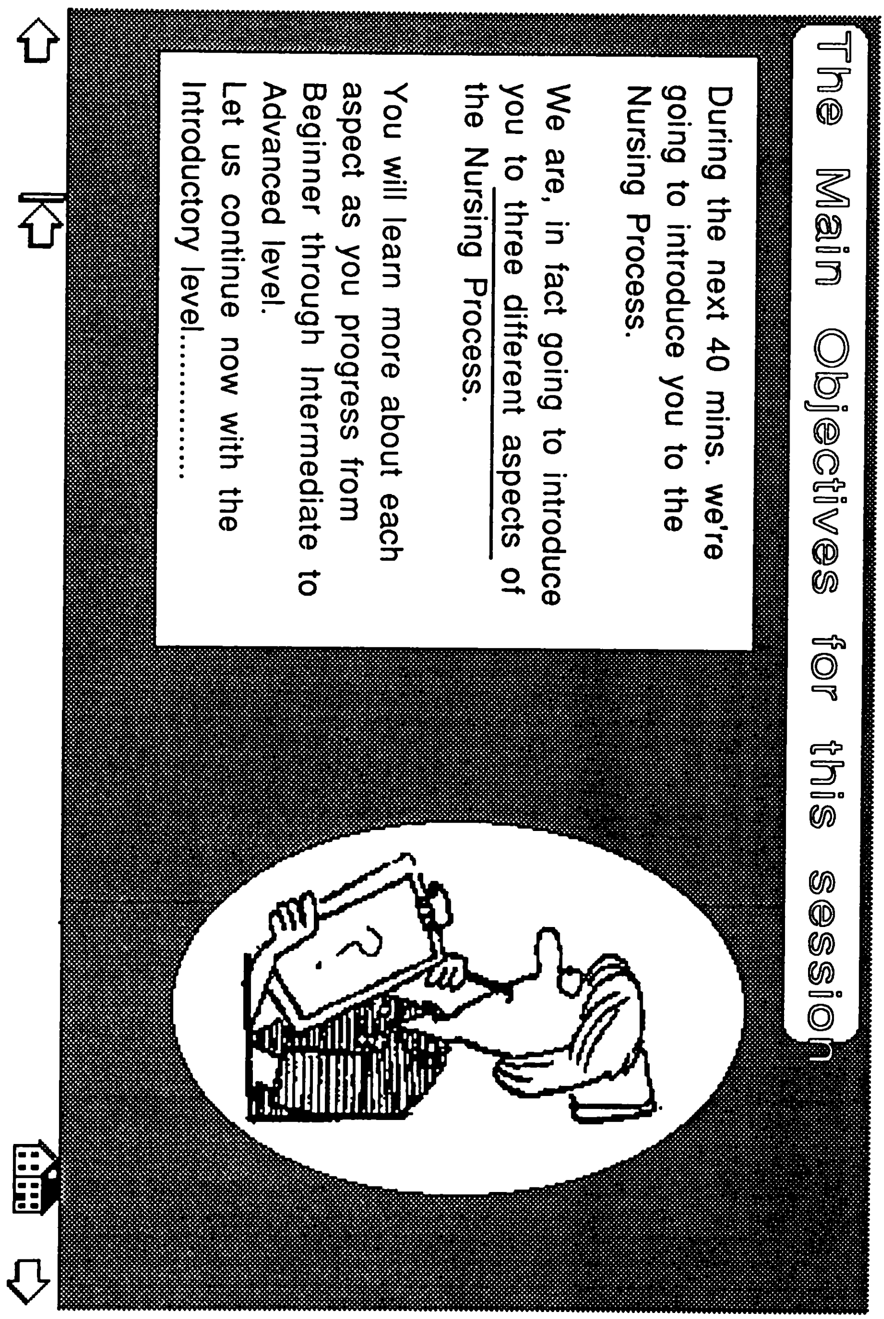
Welcome to the
Apple Macintosh

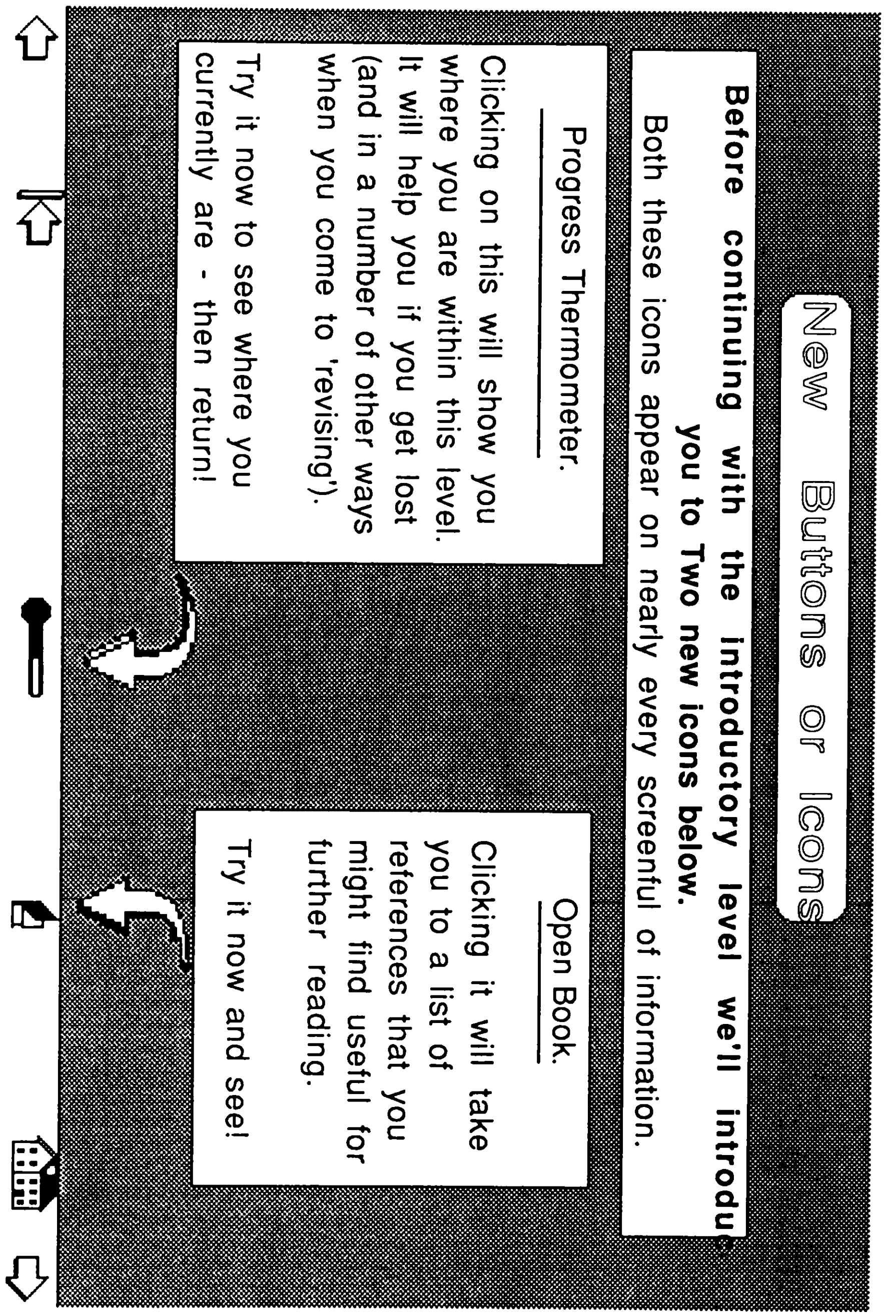
We're going to
ask you to
apply your
computer-use
skills to learn
about the

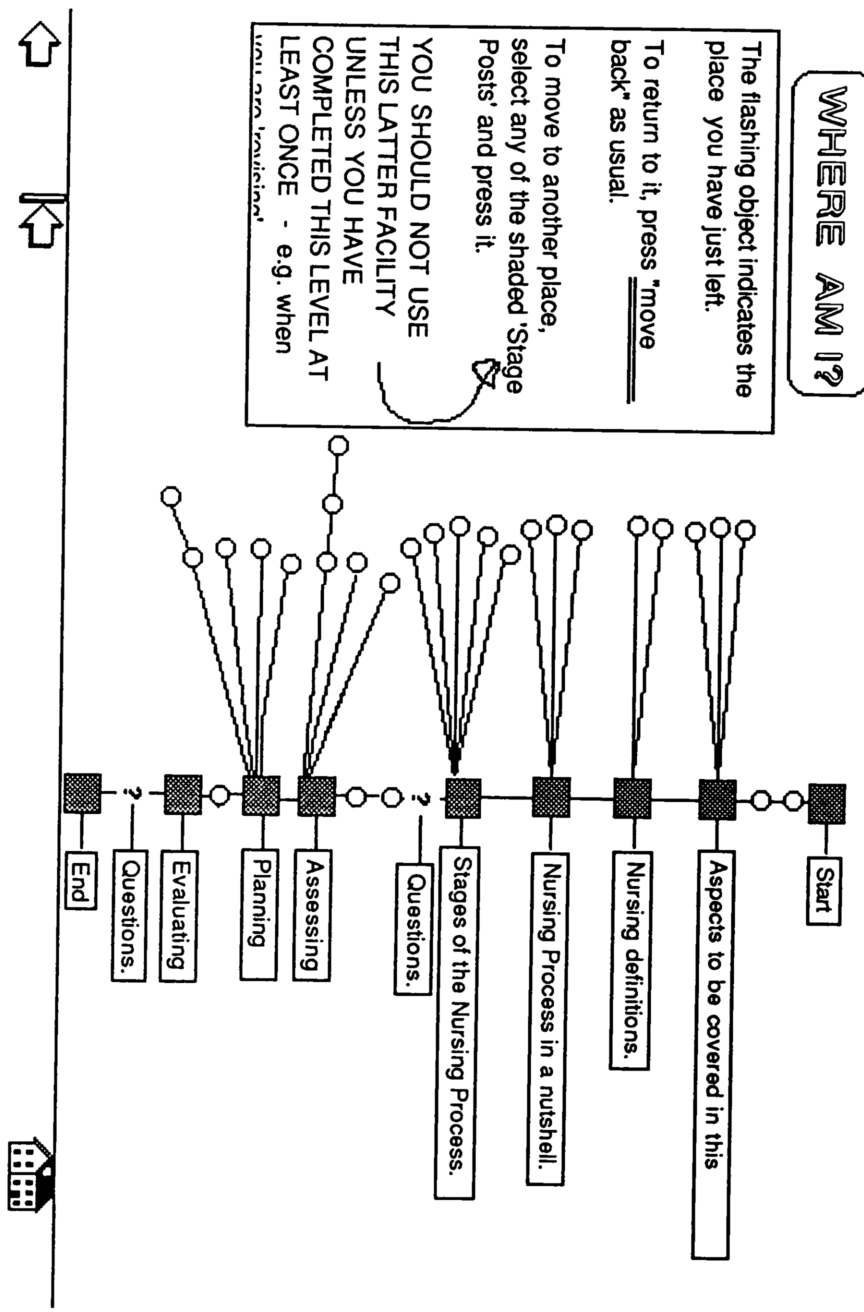
Nursing Process

Have fun!


Nursing Process
Beginner Level
apple
apple
Hi..
I'm Mac
Nurse
I hope you
enjoy learning
Welcome to the
Apple Macintosh
We're going to
ask you to
apply your
computer-use
skills to learn
about the
Nursing Process
Have fun!


The Main Objectives for this session
During the next 40 mins. we're going to introduce you to the Nursing Process.
We are, in fact going to introduce you to three different aspects of the Nursing Process.
You will learn more about each aspect as you progress from Beginner through Intermediate to Advanced level.
Let us continue now with the Introductory level..............
?


New Buttons or Icons
Before continuing with the introductory level we'll introdu you to Two new icons below.
Both these icons appear on nearly every screenful of information.
Progress Thermometer.
Clicking on this will show you where you are within this level. It will help you if you get lost (and in a number of other ways when you come to 'revising').
Try it now to see where you currently are - then return!
Open Book.
Clicking it will take you to a list of references that you might find useful for further reading.
Try it now and see!


WHERE AM I?
The flashing object indicates the place you have just left.
To return to it, press "move back" as usual.
To move to another place, select any of the shaded 'Stage Posts' and press it.
YOU SHOULD NOT USE THIS LATTER FACILITY UNLESS YOU HAVE COMPLETED THIS LEVEL AT LEAST ONCE - e.g. when
Start
Aspects to be covered in this
Nursing definitions.
Nursing Process in a nutshell.
Stages of the Nursing Process.
Questions.
Assessing
Planning
Evaluating
Questions.
End

References used in the Beginner program

Henderson V. (1960) Basic Principles of Nursing Care. International Council of Nurses Geneva.

Orem D. (1980) Nursing Concepts of Practice. McGraw Hill, New York.

Roper N. Logan W. & Tierney A. (1985) 2nd ed. The Elements of Nursing, Churchill Livingstone.

Roy C. (1984) 2nd ed. Introduction to Nursing. An Adaptation Model. p. 10-23... ....

<u>Further Reading</u>:

Kratz C. (1979), The Nursing Process. Bailliere Tindall, London.

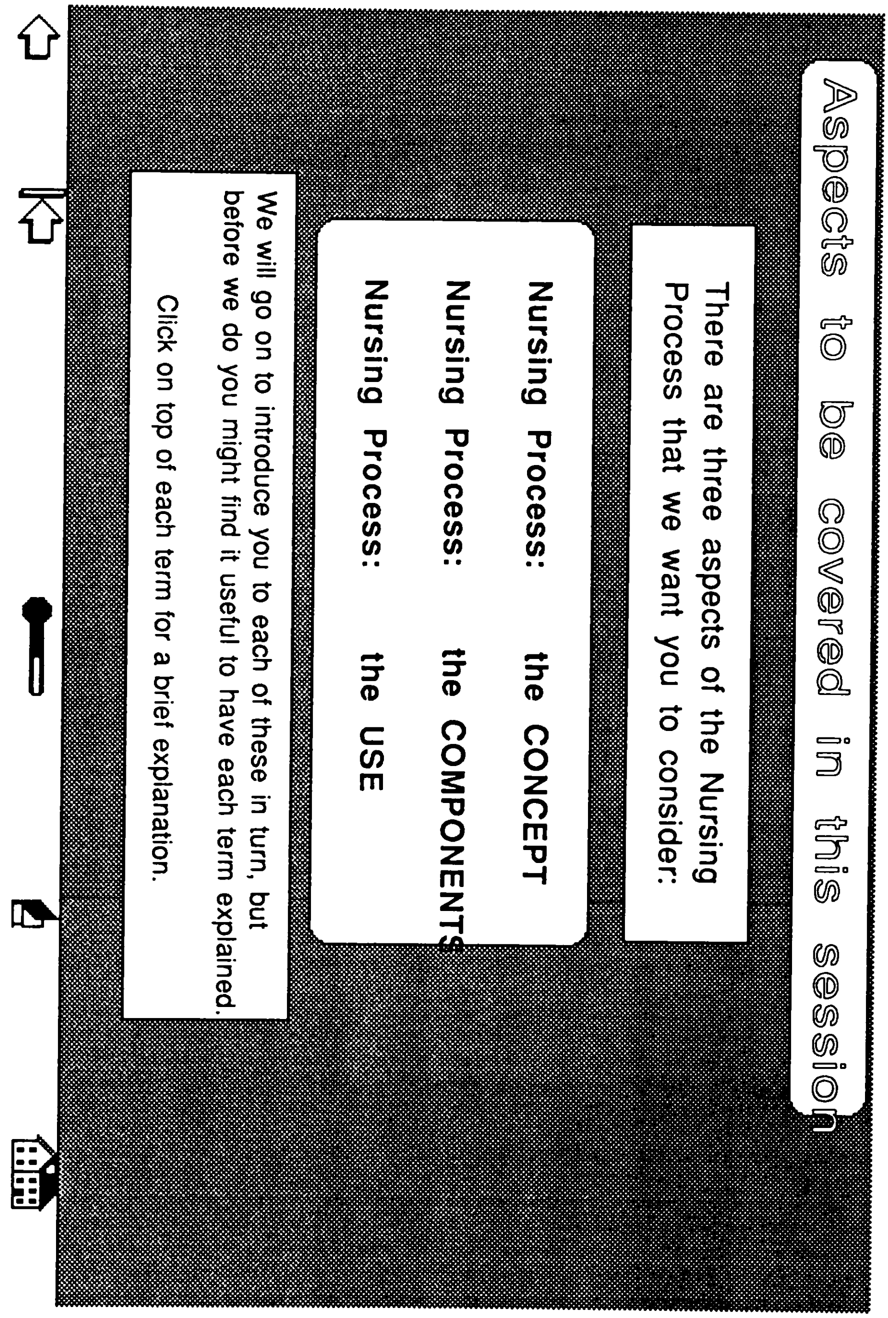
McFarlane & Castledine (1982), The Practice of Nursing. Mosby.

Mitchel T. (1984), The Nursing Process Debate. Nursing Times (May 9th).

Roper N. (1985), Pinciples of Nursing in Process Context, 3rd ed. Churchill Livingstone.

Yura & Walsh (1978), 3rd. ed. The Nursing Process. Appleton Century Crofts.

Use the "move back" arrow to return from where you came


Aspects to be covered in this session
There are three aspects of the Nursing Process that we want you to consider:
Nursing Process: the CONCEPT
Nursing Process: the COMPONENTS
Nursing Process: the USE
We will go on to introduce you to each of these in turn, but before we do you might find it useful to have each term explained.
Click on top of each term for a brief explanation.

Nursing Process - the CONCEPT

The Nursing Process is the core of curren nursing practice and nurse education.

It is a method of organising Nursing which claims to have many advantages over other methods such as, for example, task-oriente Nursing.

You'll find out more about this later

Nursing Process - the COMPONENTS

The Nursing Process usefully breaks down into four components. The presence and use of these components helps enormously in the organisation of care.

The names of the four components are:

ASSESSING
PLANNING
IMPLEMENTING
EVALUATING

Usually these components are referred to as 'stages' or steps. You will soon go on to learn more about each of these 'stages'.

Nursing Process - the USE

Once you have learned about the 'concept' of the Nursing Process and about the 'components' of the Nursing Process, you will want to know how to 'use' the Nursing Proces

Its use will be demonstrated with a simple example at this Introductory level and built up to involve more decision-making from you at t Intermediate and Advanced levels, later.

You will soon have the opportunity to use the Nursing Process in simulated case studies.

What is Nursing for?

At this point it is worth looking at a contemporary definition of the goals of Nursing since it is through the Nursing Process that these goals are most likely to be achieved.

Nursing is primarily:

1. ASSISTING the individual in the performance of those activities contributing to health, or its recovery (or to a peaceful death) that he/she would perform unaided if he/she had the necessary strength, will or knowledge.

It is likewise the unique contribution of nursing:

2. to help the individual to be INDEPENDENT of such assistance as soon as possible.

Henderson V. (1960)

You might like to have the terms in upper case alongside explained more fully - in which case simply click on top of a term for a brief explanation

... and THEN 'move on'.

Nursing - a substitute for a patient's health deficit

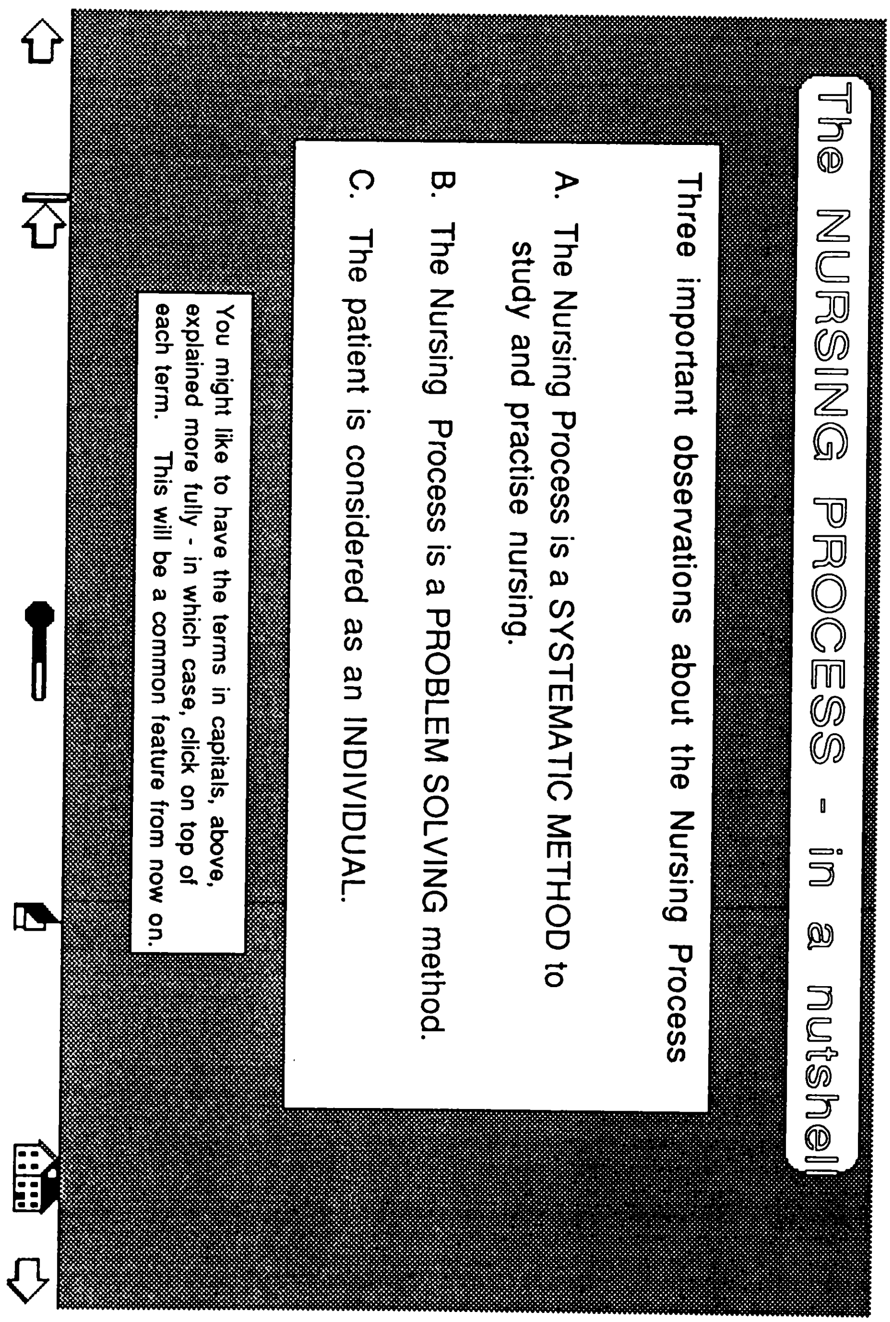
Nursing assists with meeting basic human needs for life and health, that is meeting the deficiencies of people in carrying out daily living activities. The Nurse helps patients with deficits in their self care ability. This is describes by D. Orem as the patient's health deficit, which may refer to a deficit in physical strength, will or knowledge.

More recently, the role of Nursing in contributing to and promoting an individuals health (as opposed to illness) is being emphasised.

Nursing - promoting patient independance

The activities of Nursing give help or assistance whilst promoting and <u>maximising the self care abilities</u> of the individual.

Where it is not possible for the individual to regain their full ability in self care, Nursing aims to educate the individual in coping with the effects of their disability or illness through the <u>provision of information</u> about their current and potential health status and through the exposure to a wide range of activities relating to rehabilitation.


The NURSING PROCESS - in a nutshell
Three important observations about the Nursing Process
A. The Nursing Process is a SYSTEMATIC METHOD to study and practise nursing.
B. The Nursing Process is a PROBLEM SOLVING method.
C. The patient is considered as an INDIVIDUAL.
You might like to have the terms in capitals, above, explained more fully - in which case, click on top of each term. This will be a common feature from now on.

The Nursing Process - Systematic Nursing

The Nursing Process is an organised sequence of events - a systematic method of nursing patients which has been recommended by the profession since the 1970s.

Systematic methods such as this, are not unique to Nursing.
Other professions benefit from their use, too - for example, the Management Process in Management, the Engineering Process in Engineering and even the Scientific Method (or Process) that is the backbone of Science.

The Nursing Process - a Problem Solving method.

The Nursing Process is a method of nursing which involves the identification of problems.

The problems may be described as either actual problems or potential problems. eg. An elderly individual who is very thin and confined to bed will have a potential problem of pressure sores, even though there is no evidence at the assessment of there being an actual problem of pressure sores.

Potential problems encourage the nurse to plan for the prevention of actual problems occuring.

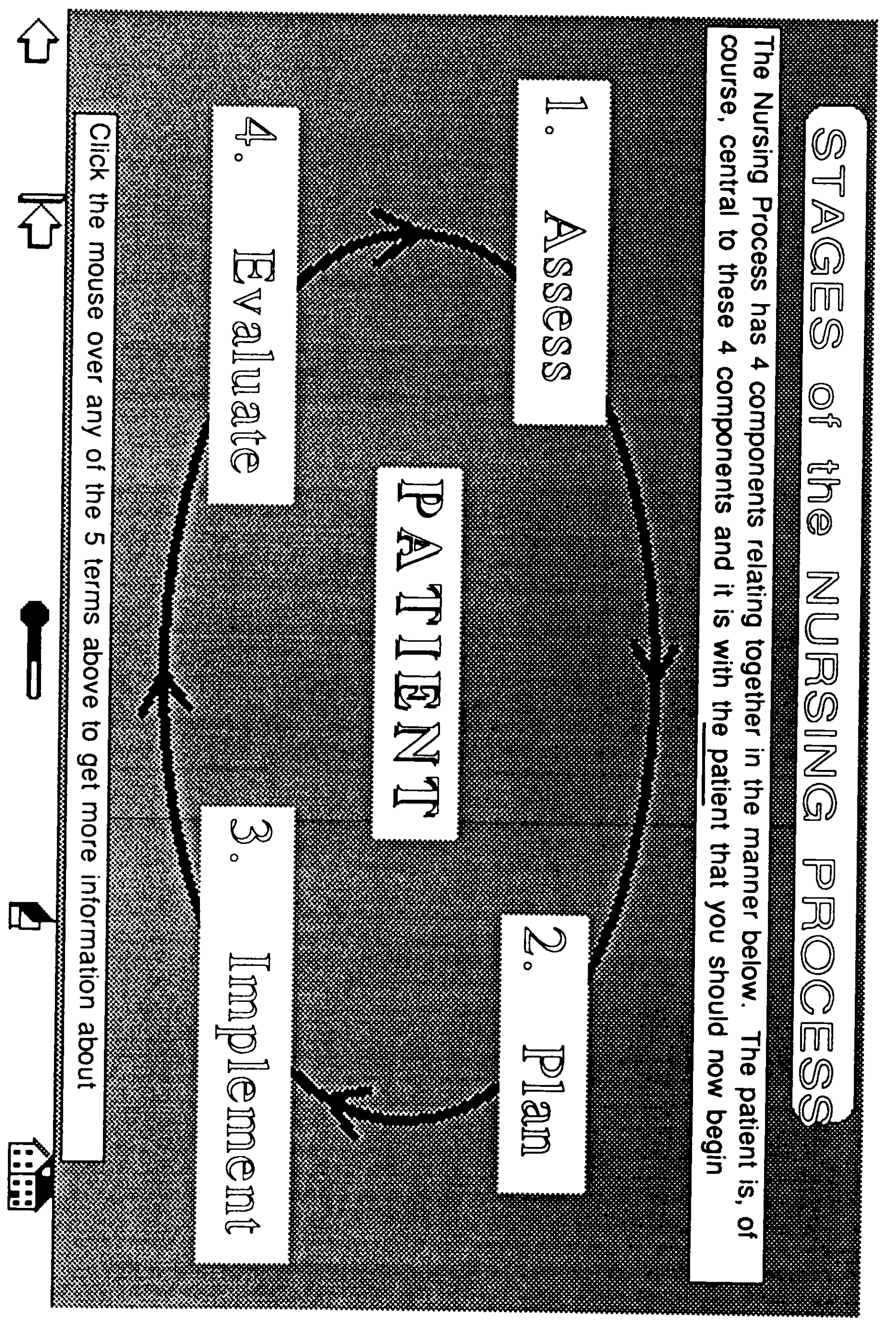
You'll be seeing many examples of this, later.

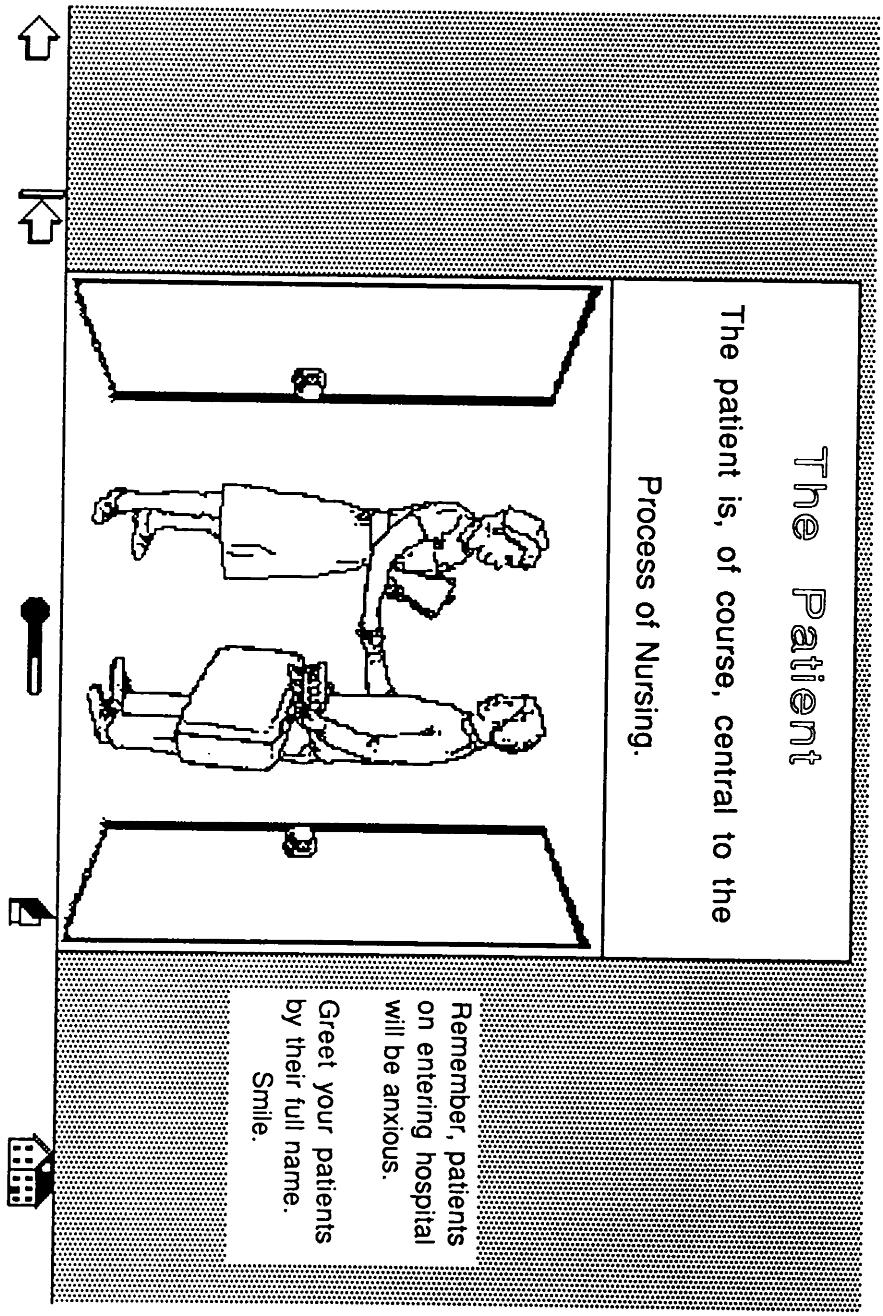
The Nursing Process - Individually orientated

Nursing is directed towards the individual patient rather than their illness.
Patients may well have the <u>same illness</u> but may have individual and <u>different problems</u> associated with it - through their own lifestyle and social and psychological makeup, for example.

The <u>total care</u> of the patient is taken into consideration with all aspects of a patient's current situation being heeded.

You'll see plenty of examples to illustrate this point, later on.


STAGES of the NURSING PROCESS
The Nursing Process has 4 components relating together in the manner below. The patient is, of course, central to these 4 components and it is with the patient that you should now begin
1. Assess
2. Plan
3. Implement
4. Evaluate
PATIENT
Click the mouse over any of the 5 terms above to get more information about


The Patient
The patient is, of course, central to the Process of Nursing.
Remember, patients on entering hospital will be anxious.
Greet your patients by their full name.
Smile.

Assessment Stage of the Nursing Process

The assessment involves gathering information about the patient:

1. by reading the patient's notes
2. by observing the patient
3. by communicating with the patient and relatives
4. by listening.

From the information gathered, problems and potential problems are subsequently identified: problems that constitute a 'health care deficit', that is problems that the nurse and patient have reached agreement about.

The goal of the assessment stage of the Nursing Process is problem identification.

Planning Stage of the Nursing Process

Once the problems and potential problems have been identified, appropriate nursing care is planned as follows:

the problems are prioritised

for each problem, goals are set which take into account the current and potential capabilities of the individual patient

appropriate actions are chosen to help the patient achieve each goal

The goal of the planning stage of the Nursing Process is to determine the plan of care incorporating the details above. This is documented in a Care Plan.

Implementation Stage of the Nursing Process

The written Care Plan gives direction to the implementation of nursing care and it is a legal document in a court of law.

Just as

it is the responsiblility of the individual nurse to ensure that the Care Plan reflects the real needs of the patient,

so

it is equally the nurse's professional responsibility to ensure that the care actually delivered reflects what is written in the Care Plan.

The goal of the implementation stage of the Nursing Process is to deliver the care planned.

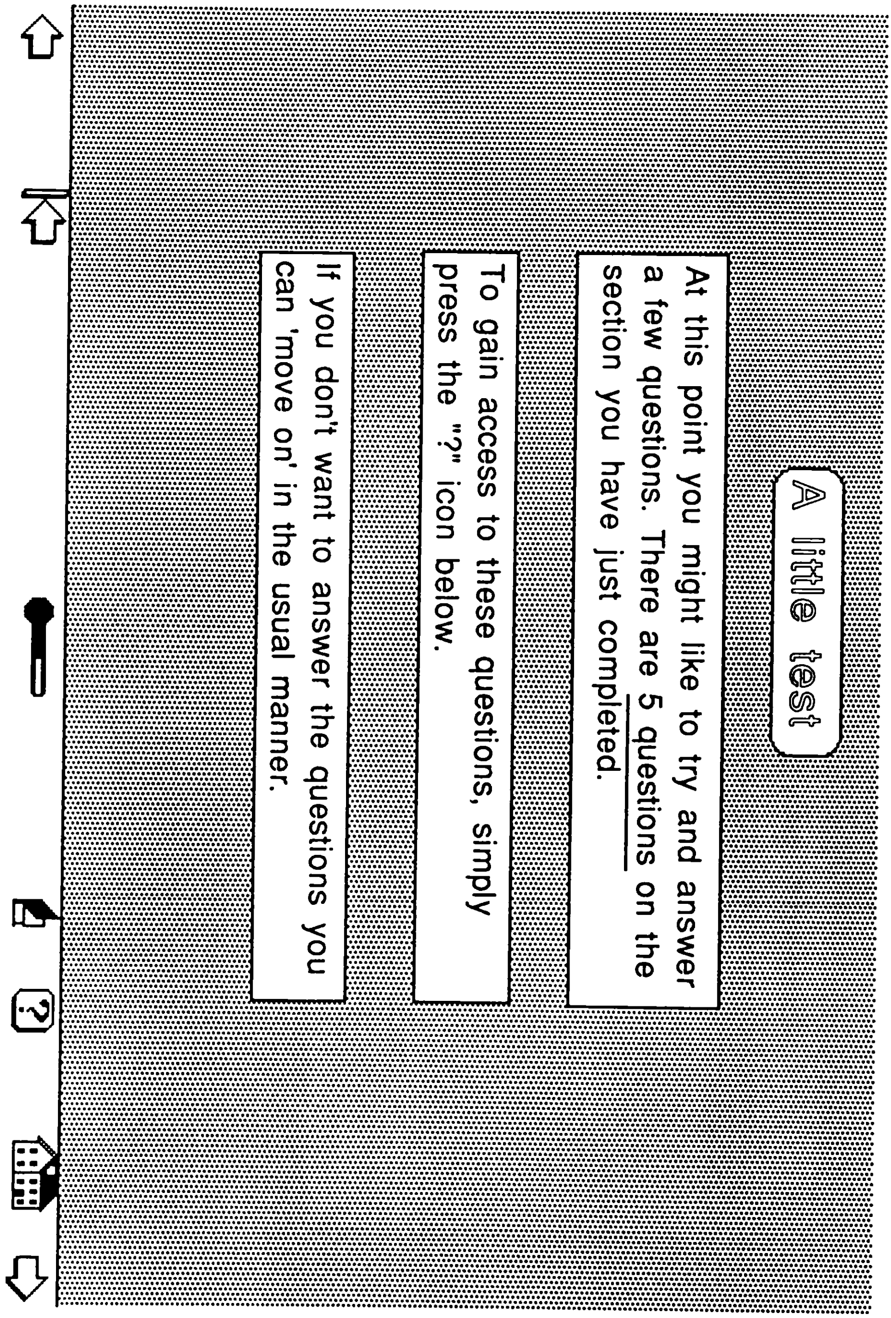
Evaluation Stage of the Nursing Process

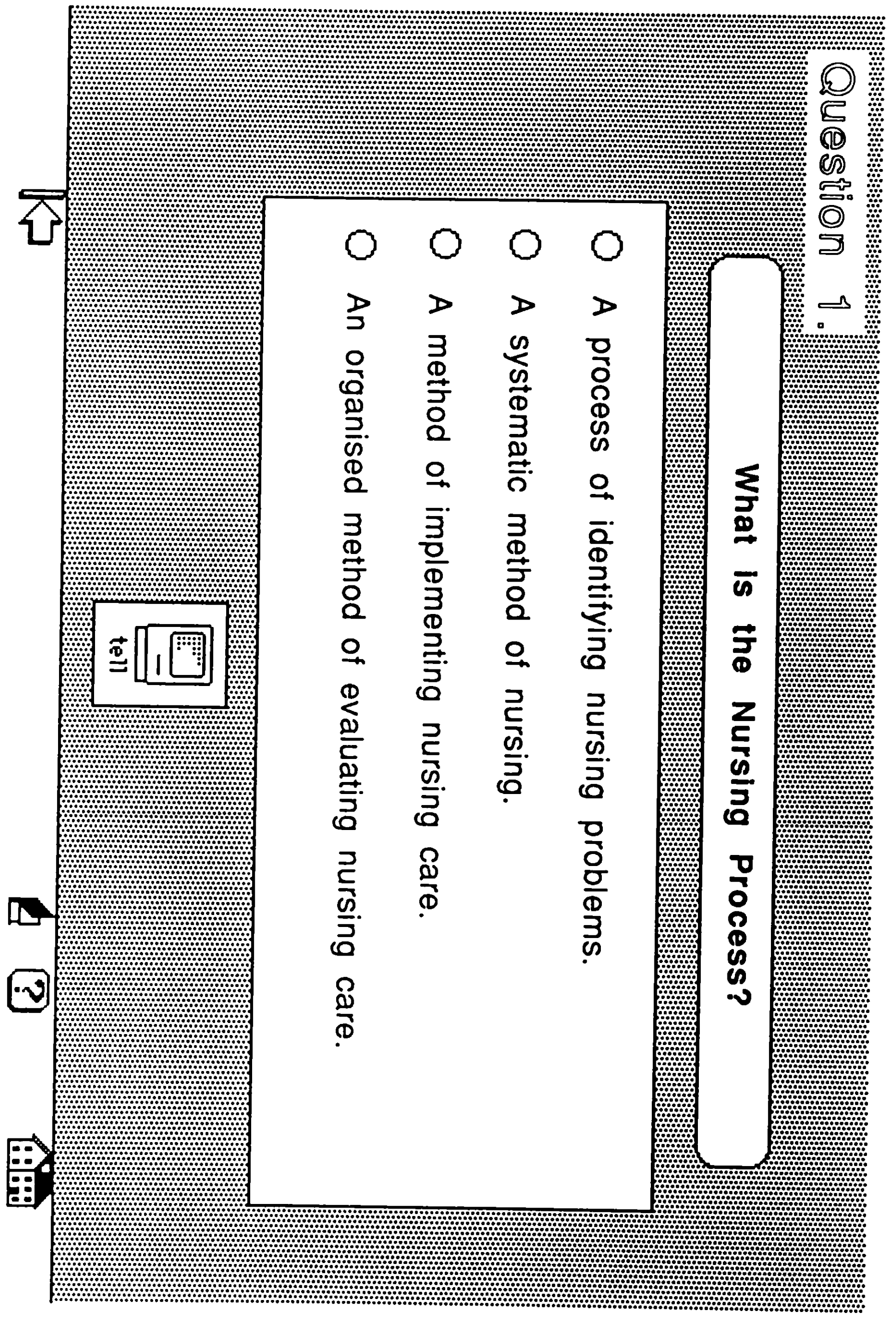
Evaluation is closely linked to Assessment.
Accurate Assessment and Planning with specific Action planned to achieve patient goals provides the criteria and the information for the Evaluation stage.

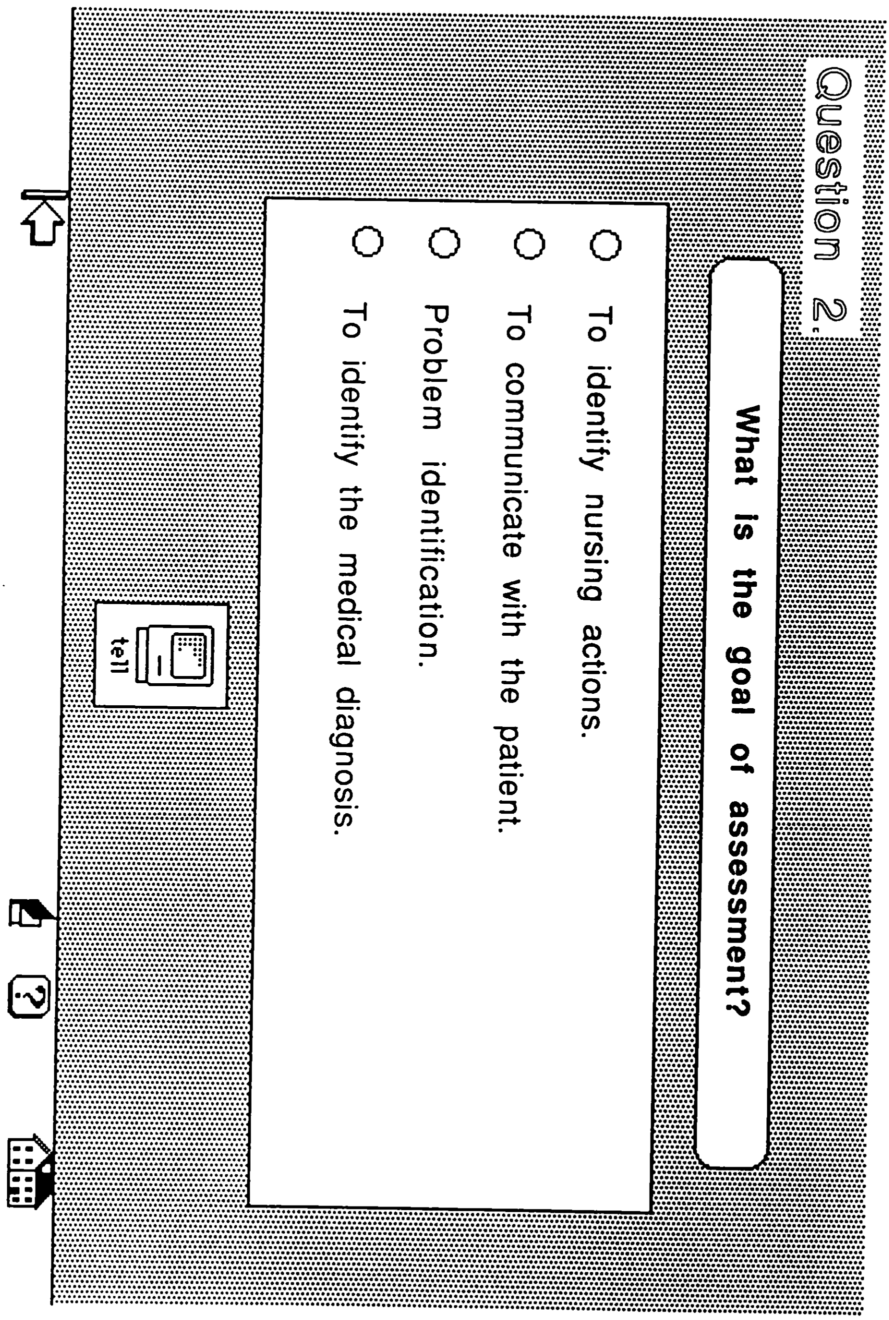
On the basis of evaluation, planned actions are maintained, modified or replaced

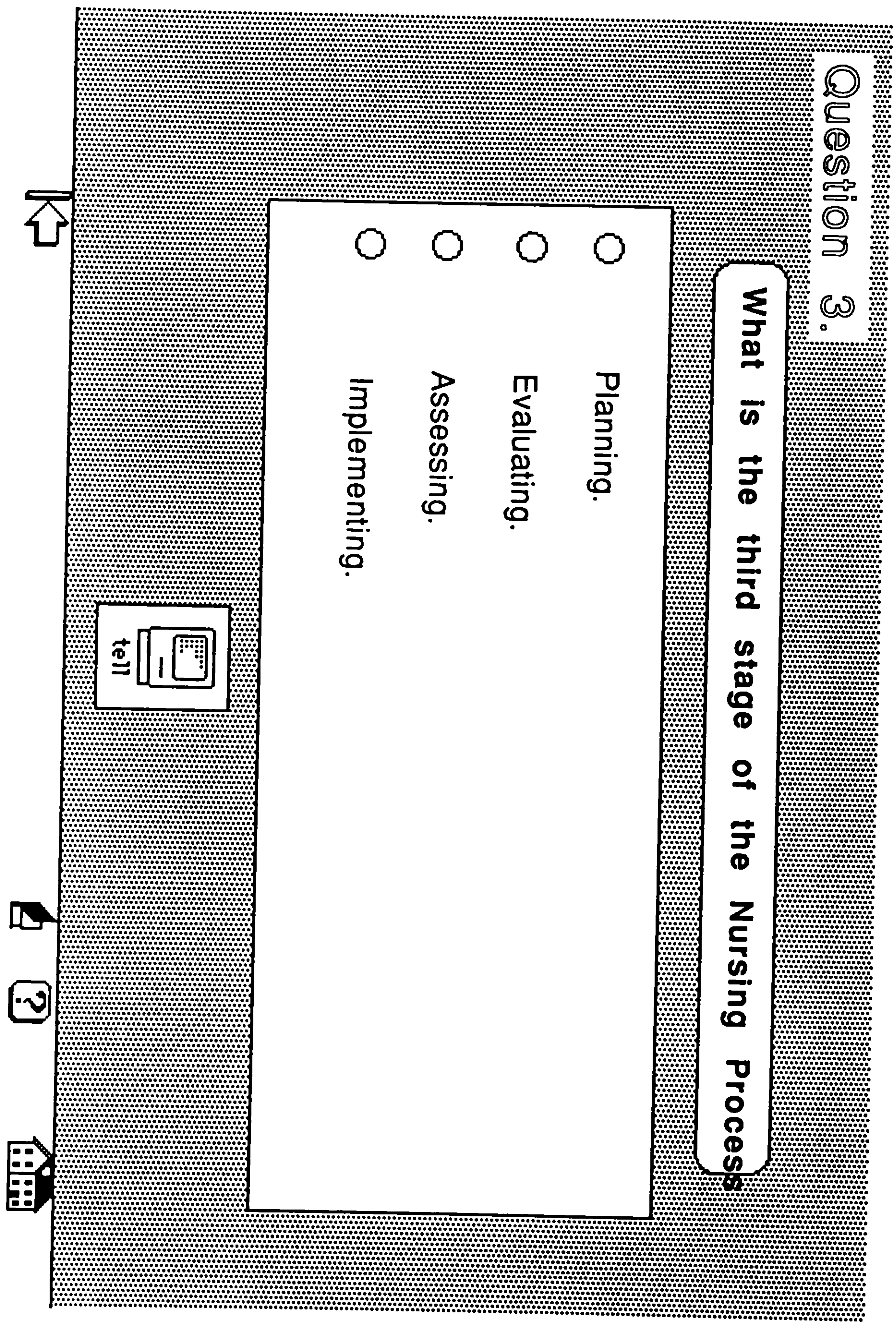
The goal of the evaluation stage of the Nursing Process is to identify the extent to which the patient goals set have been met by the actions planned and implemented.

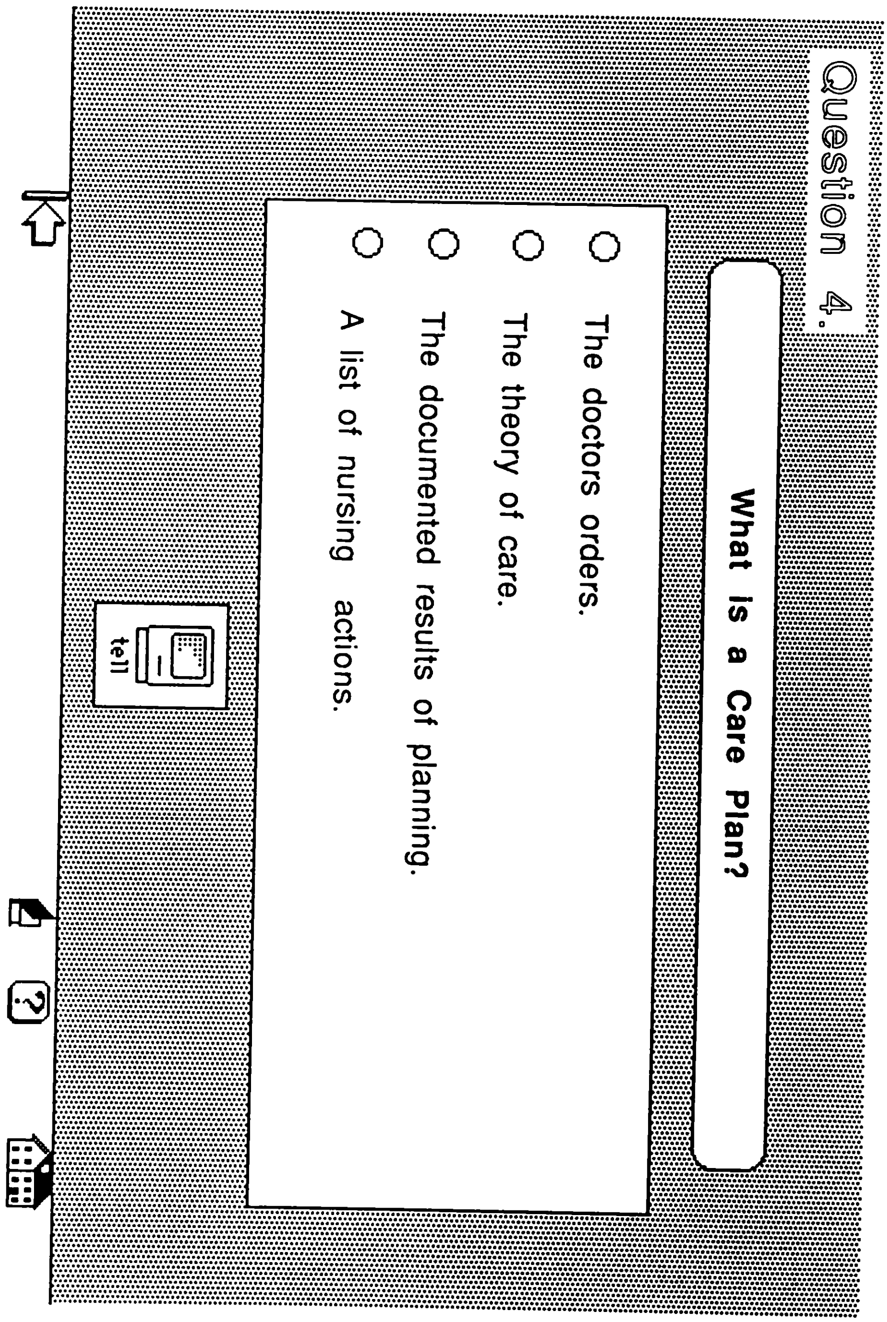
Effectively, this stage merges with the Assessment stage and another cycle of the Nursing Process is begun !

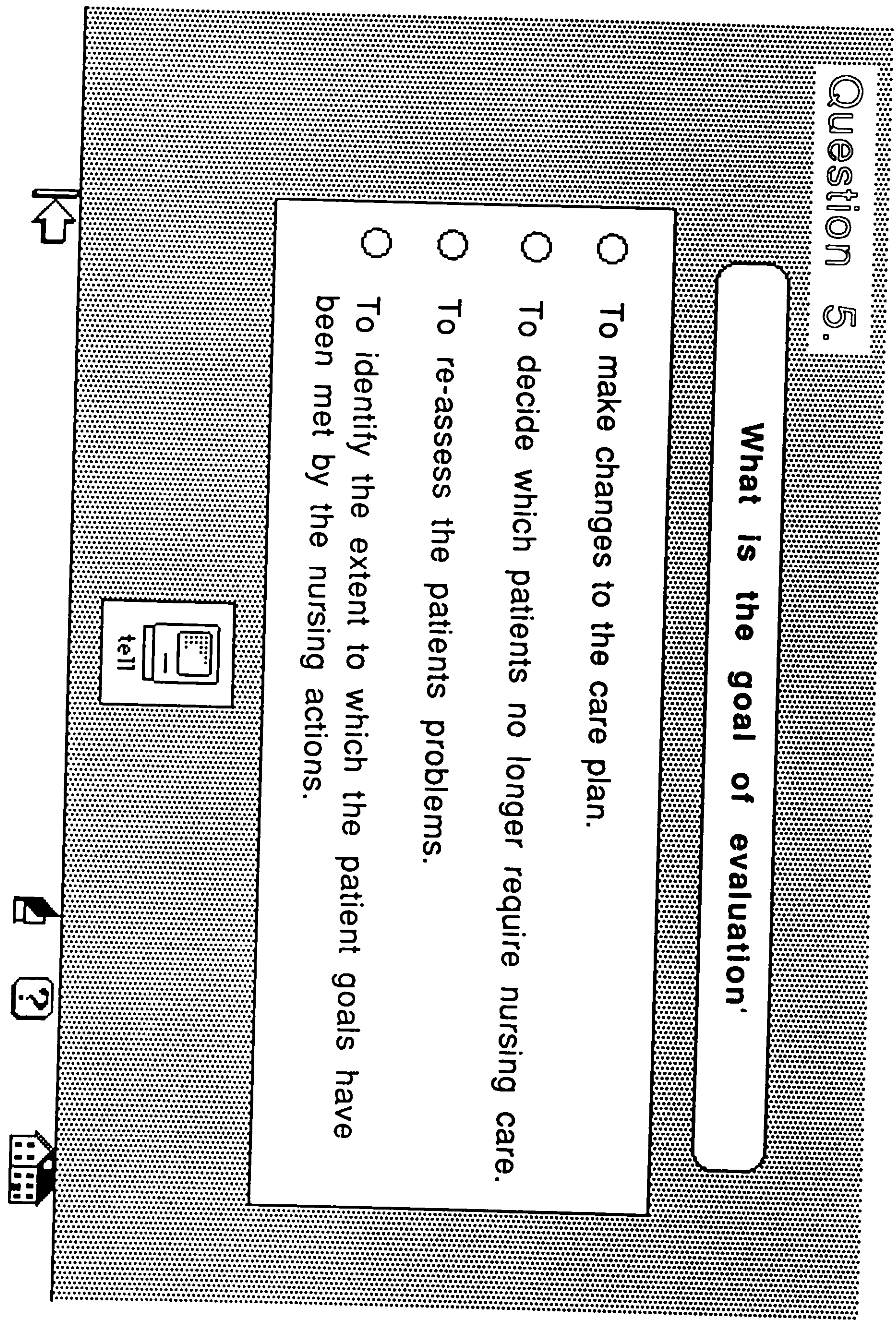

A little test
At this point you might like to try and answer a few questions. There are 5 questions on the section you have just completed.
To gain access to these questions, simply press the "?" icon below.
If you don't want to answer the questions you can 'move on' in the usual manner.

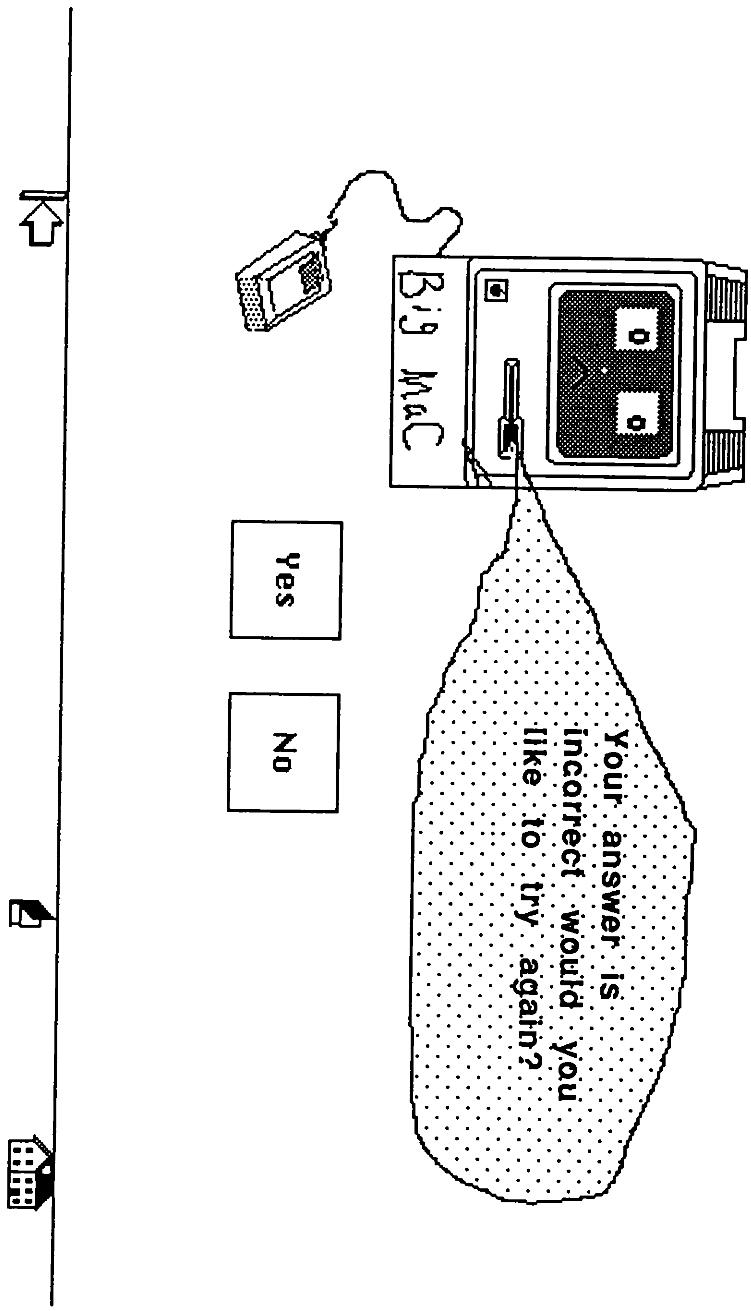

Question 1.
What is the Nursing Process?
A process of identifying nursing problems.
A systematic method of nursing.
A method of implementing nursing care.
An organised method of evaluating nursing care.
tell

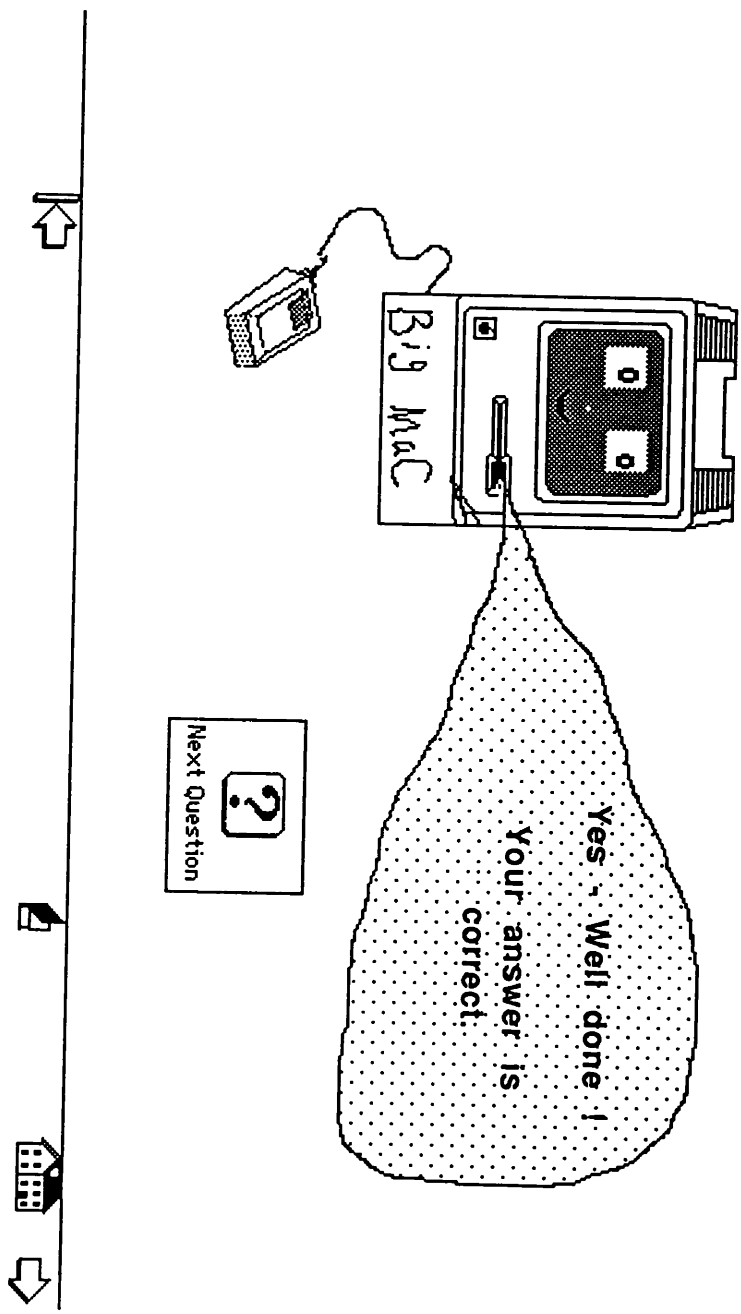

Question 2.
What is the goal of assessment?
To identify nursing actions.
To communicate with the patient.
Problem identification.
To identify the medical diagnosis.
tell

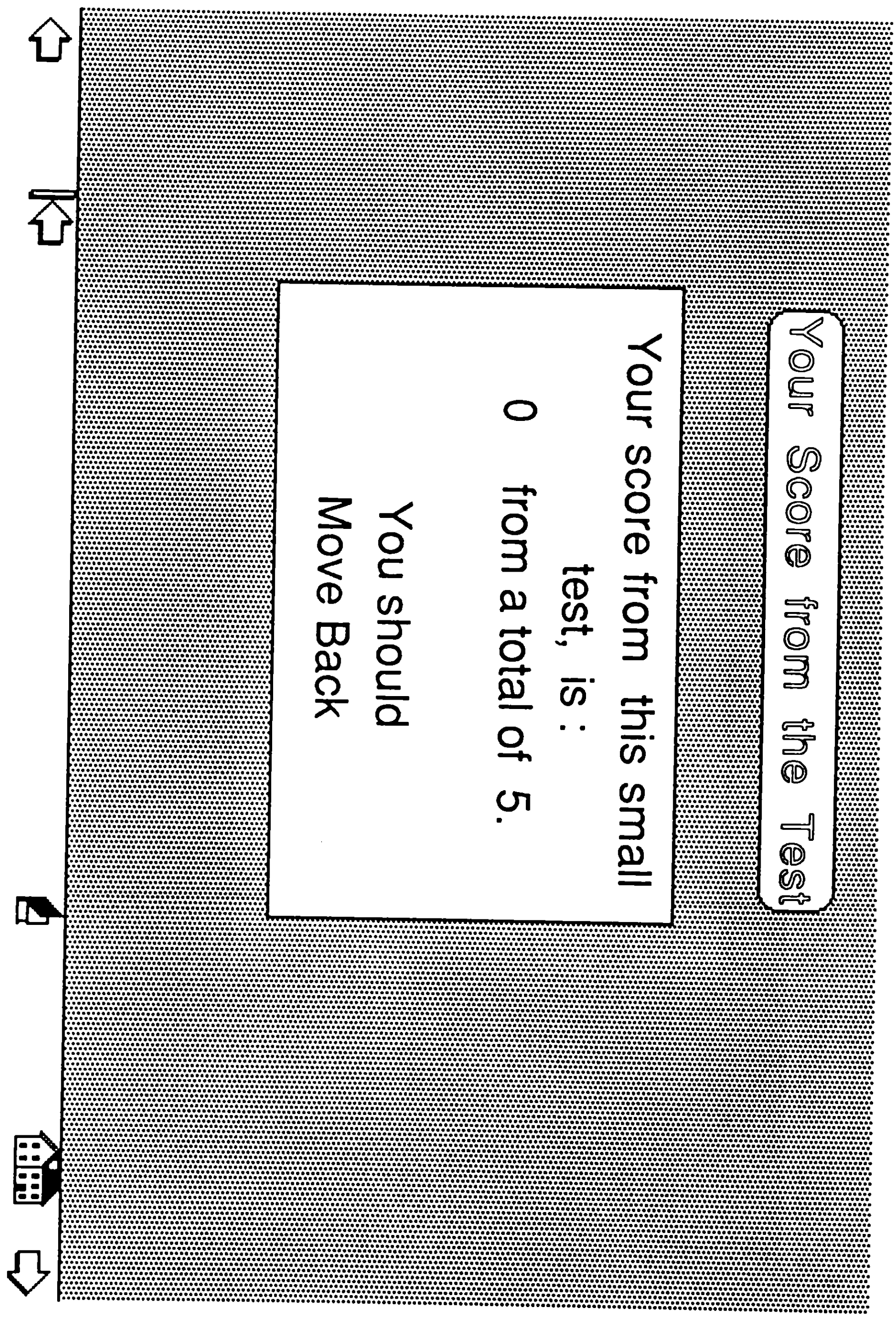

Question 3.
What is the third stage of the Nursing Process
Planning.
Evaluating.
Assessing.
Implementing.
tell

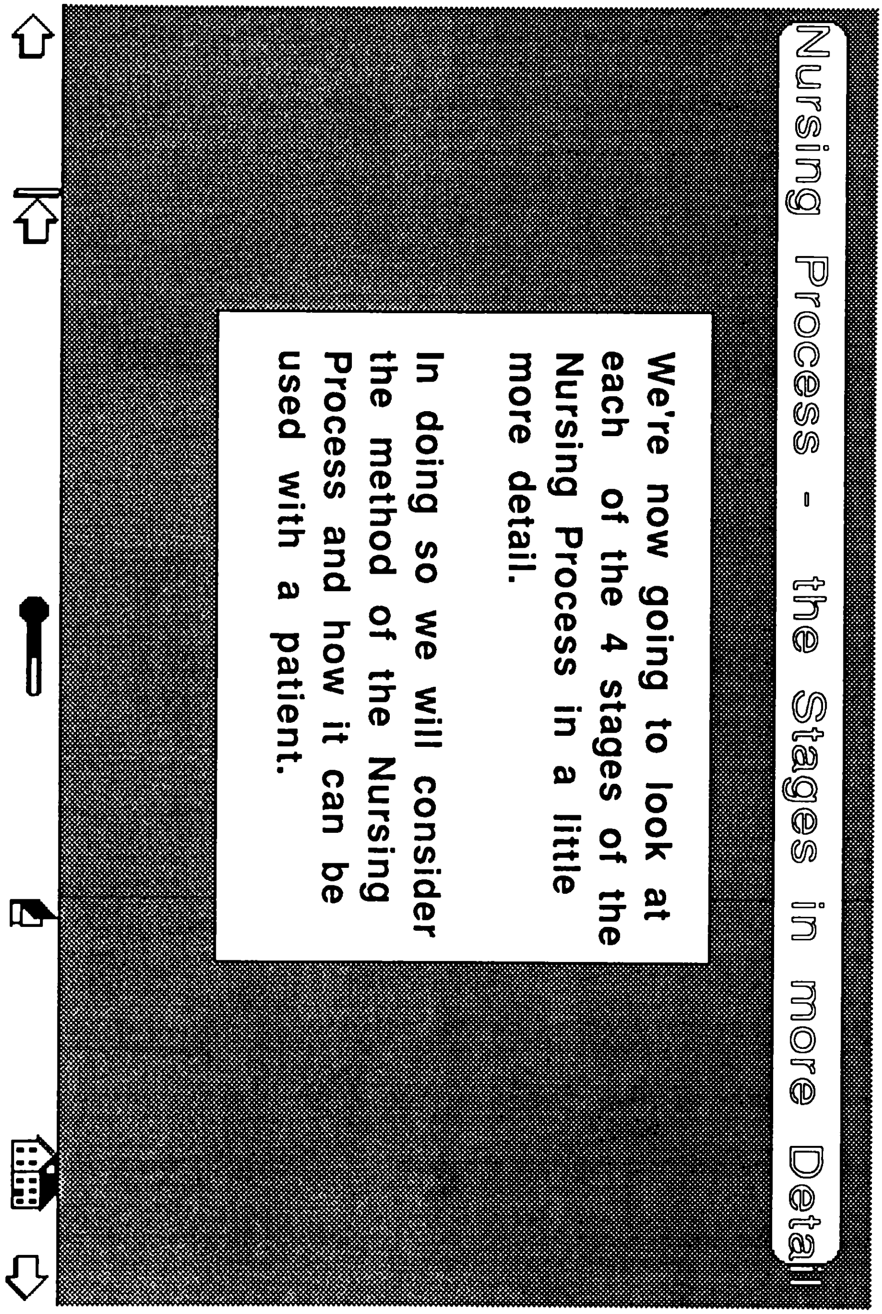

Question 4.
What is a Care Plan?
The doctors orders.
The theory of care.
The documented results of planning.
A list of nursing actions.
tell


Question 5.
What is the goal of evaluation'
To make changes to the care plan.
To decide which patients no longer require nursing care.
To re-assess the patients problems.
To identify the extent to which the patient goals have been met by the nursing actions.
tell


Big MaC
Your answer is incorrect would you like to try again?
Yes
No


Big MaC
Yes - Well done !
Your answer is
correct.
Next Question

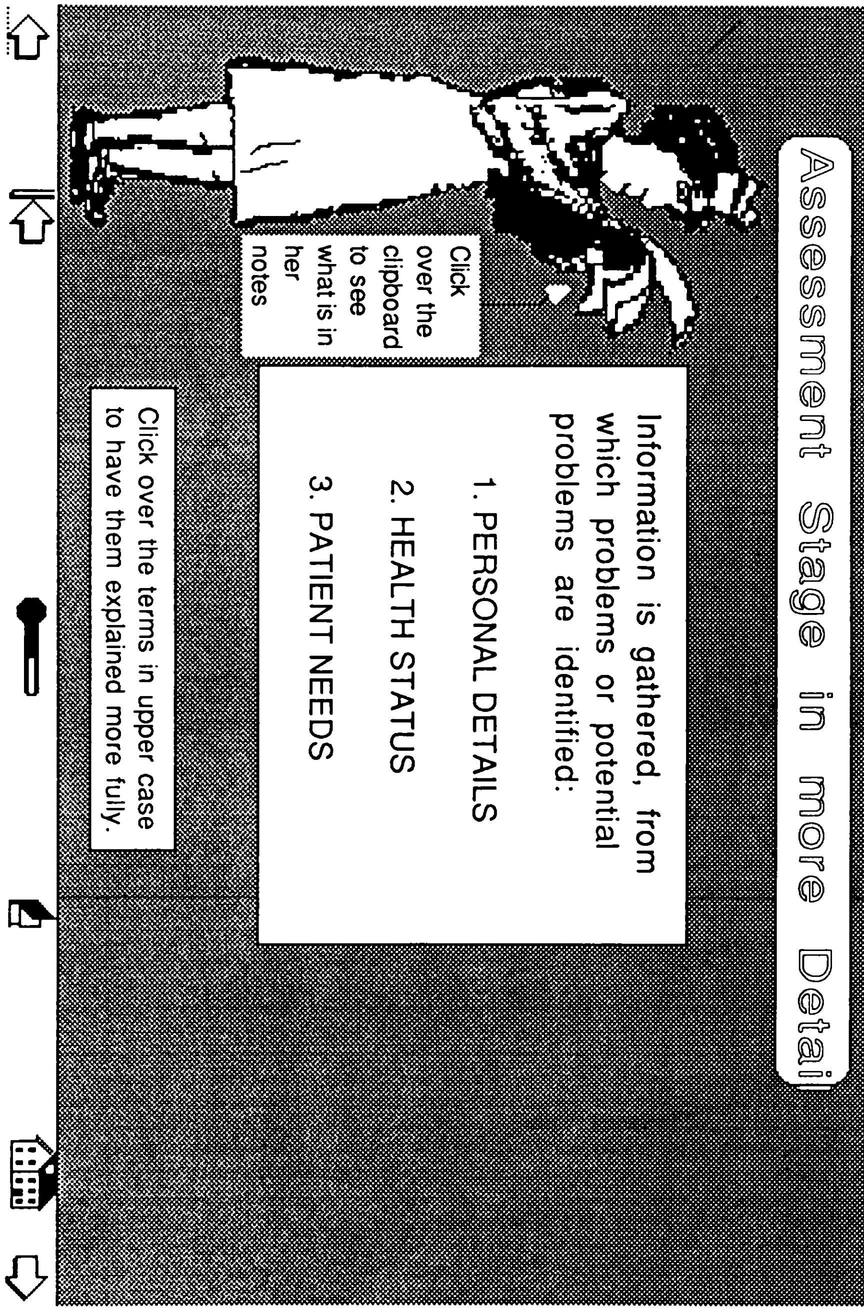

Your Score from the Test
Your score from this small
test, is :
0 from a total of 5.
You should
Move Back

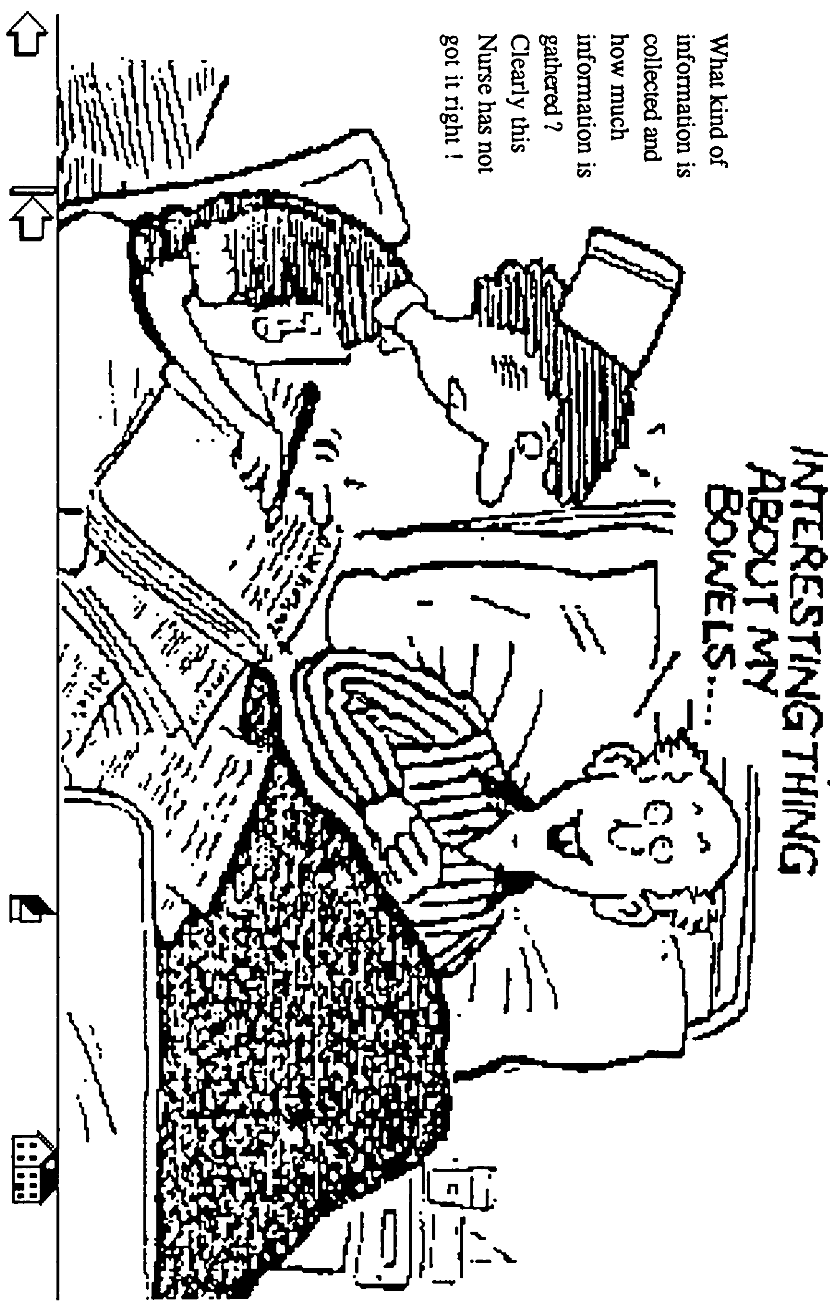

Nursing Process - the Stages in more Detail
We're now going to look at each of the 4 stages of the Nursing Process in a little more detail.
In doing so we will consider the method of the Nursing Process and how it can be used with a patient.

Patient in Detail

This is Mr McTaggart. You were informed, by the medical staff, that he was going to be admitted, from home, for investigations of an acute chest infection.

Mr Mctaggart is comfortable and nurse arranges the environment for privacy.


Assessment Stage in more Detai
Click over the clipboard to see what is in her notes
Information is gathered, from which problems or potential problems are identified:
1. PERSONAL DETAILS
2. HEALTH STATUS
3. PATIENT NEEDS
Click over the terms in upper case to have them explained more fully.


- AND THE OTHER INTERESTING THING ABOUT MY BOWELS....
What kind of information is collected and how much information is gathered ? Clearly this Nurse has not got it right !

Personal Details

A blank form will build up below. Contained in the form is the sort of information which would be collected under the heading of personal details.

Name..	Identification Nos..........................
Address..	Sex................... Age..........................
....	D.O.B..
....	Weight................Height...................
	Marital status....................................
Occupation..	Religion..

Much of the personal information will be available elsewhere, but the nurse must verify that the information is correct. The patient is given an Identification number. Accurate personal information identifies the individual and will reduce the possibility of error eg. sending someone else's notes with the patient to the operating theatre.

Click on this text to build up the information on the blank form.

Personal Details

Date of Admission........3-3-90.........................Date of Assessment..........3-3-90.....

Name................James McTaggart...............	Identification Nos..........732165...
Address..	Sex.........M........ Age.......68...............
..................Flat 16 Possil Park......................	D.O.B. 5-4-1922.................................
....	Weight.......8st 7lb Height........5ft 8ins
	Marital status...........Widowed..........
Occupation.........Retired Miner.....................	Religion..............Protestant...............
Next of Kin.......Ewan McTaggart............	Social History............Lives alone...
Address.....East London..........................	...............in a second storey flat
......................England................................	....
.......Tel. 01- 637-8091.........................	....
Relationship.......Son.................................	....

Health Status

A blank form will build up below. Contained in the form is the sort of information which would be collected under the heading of Health Status.

Reason for Admission	Medical Diagnosis
....	....
....	....

The patients admission to hospital maybe planned, in which case the reason for admission will be found from the patients notes and / or documentation with which the patient arrives. Alternatively in an emergency admission the nurse in charge will have been informed of the reason from the medical staff.

The medical diagnosis should be left until confirmed by the medical staff.

Click on this text to build up the information on the blank form.

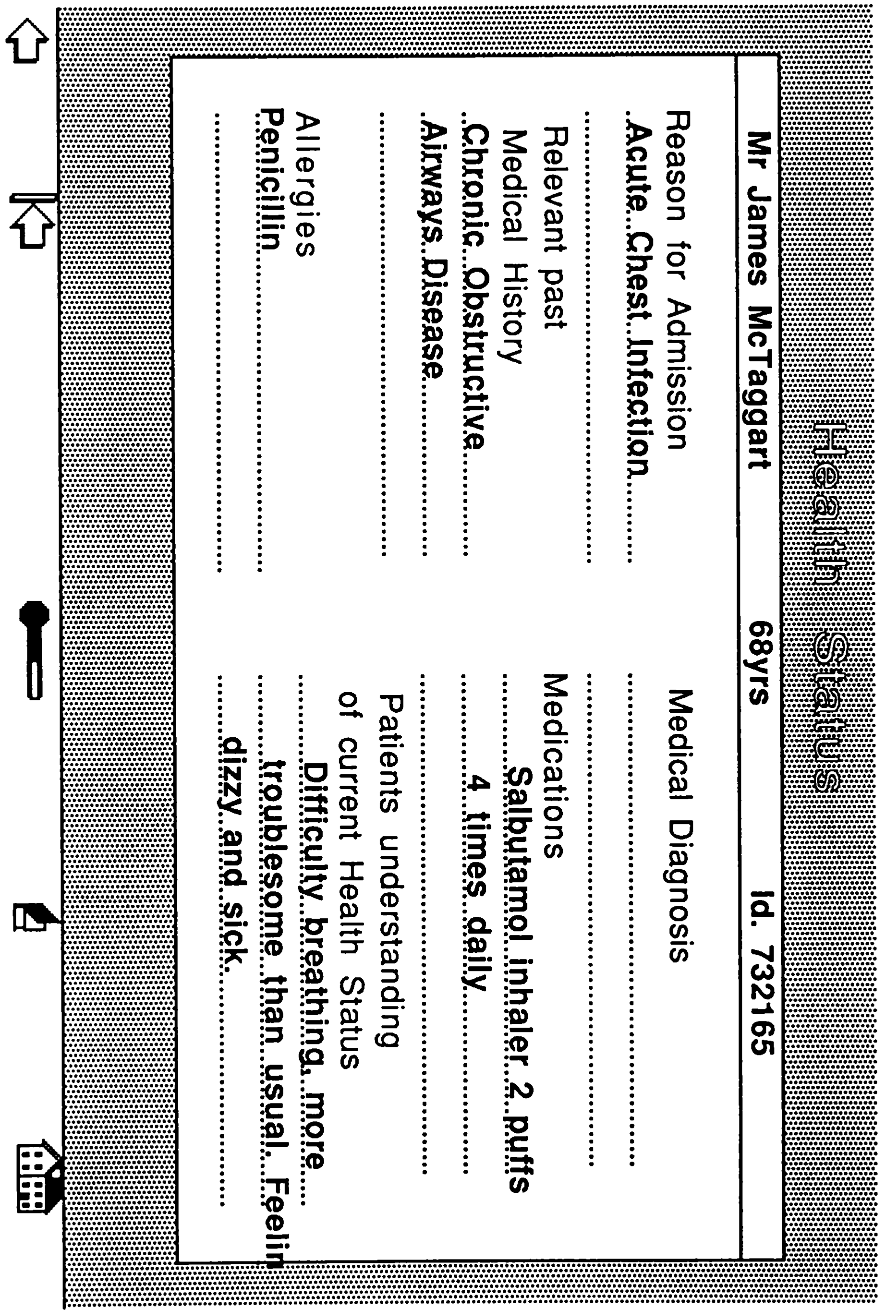
Health Status

A blank form will build up below. Contained in the form is the sort of information which would be collected under the heading of Health Status.

Reason for Admission	Medical Diagnosis
....	....
....	....
Relevant past Medical History	Medications
....	....
....	....
....	....
	Patients understanding of current Health Status
Allergies	....
....	....

It is important to identify whether the patients have accurate information about their illness, they may have unecessary fears or unrealistic expectations about the course of their illness.

Click on this text to complete the blank form.


Health Status
Mr James McTaggart
68yrs
Id. 732165
Reason for Admission
Acute Chest Infection
Relevant past
Medical History
Chronic Obstructive
Airways Disease
Allergies
Penicillin
Medical Diagnosis
Medications
Salbutamol inhaler 2 puffs
4 times daily
Patients understanding
of current Health Status
Difficulty breathing, more
troublesome than usual. Feelin
dizzy and sick.

Patient Needs

A Nursing Model is useful to help focus attention and give direction in the search for patients Health Deficits. A nursing model provides a theoretical framework of nursing, but a model simply provides guidance and can be modified to suit specific needs.

There are several different Nursing models in use for examples see (Roy C. 1984 p. 10- 13) .

The model which is used in this program is the ACTIVITIES OF LIVING (Roper et al) based on Henderson's concept and goals of Nursing.

Click on top the term in capitals to have it explained more fully.

Activities of Living Model to Assess Patient Needs.

1. Maintaining a safe environment
2. Communicating
3. BREATHING
4. Eating & drinking
5. Eliminating
6. Personal cleansing and dressing
7. Controlling body temperature
8. Mobilising
9. Working and playing
10. Expressing sexuality
11. Sleeping
12. Dying

Roper N. Logan W. & Tierney A.

The 12 Activities of Living form the main component of the model. Nursing aims to help patients solve, alleviate, cope with or prevent problems within any of the Activities.

Each activity has many dimensions. Some have greater priority than others eg. breathing.

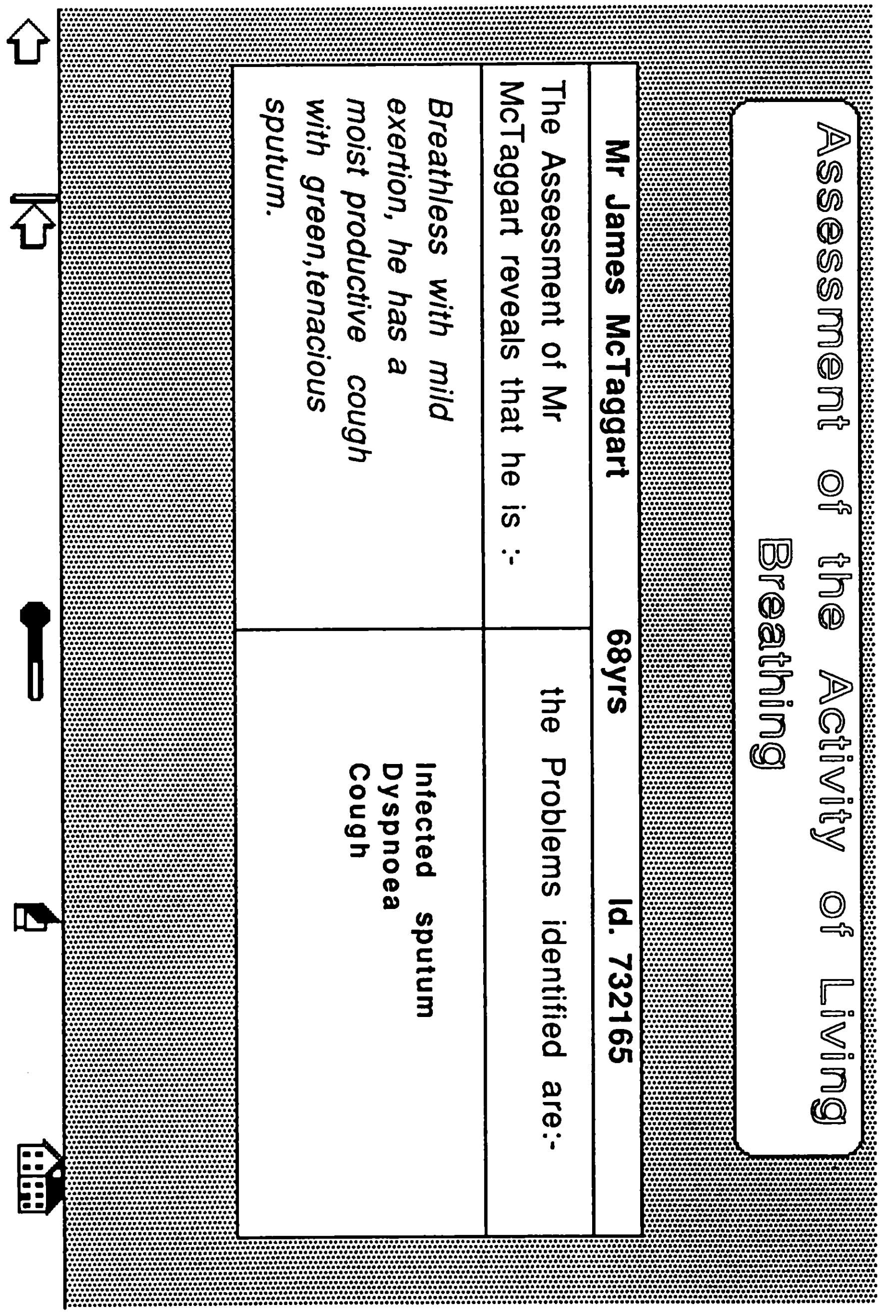
Click over the Activity in capital letters for an example.

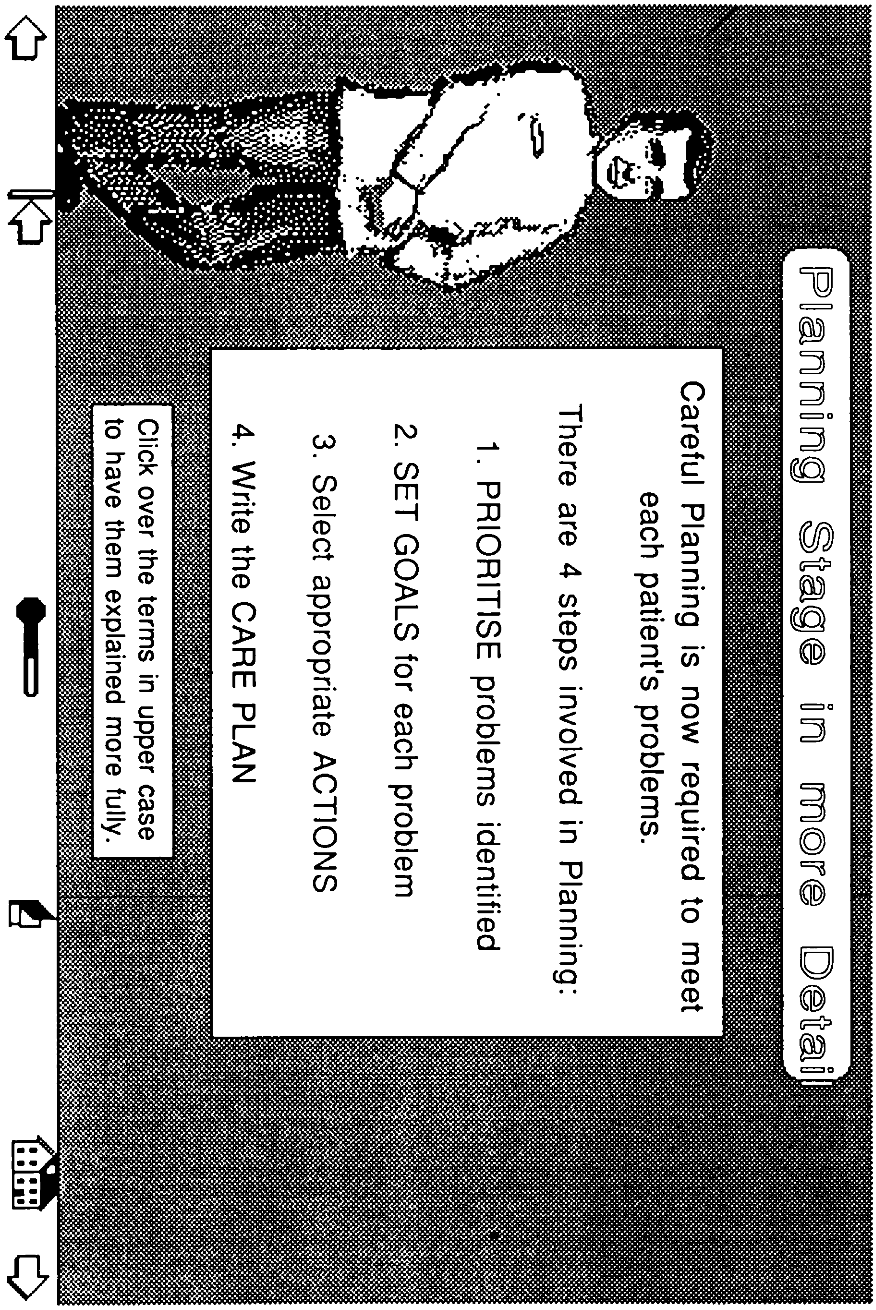
Assessment of the Activity of Living Breathing

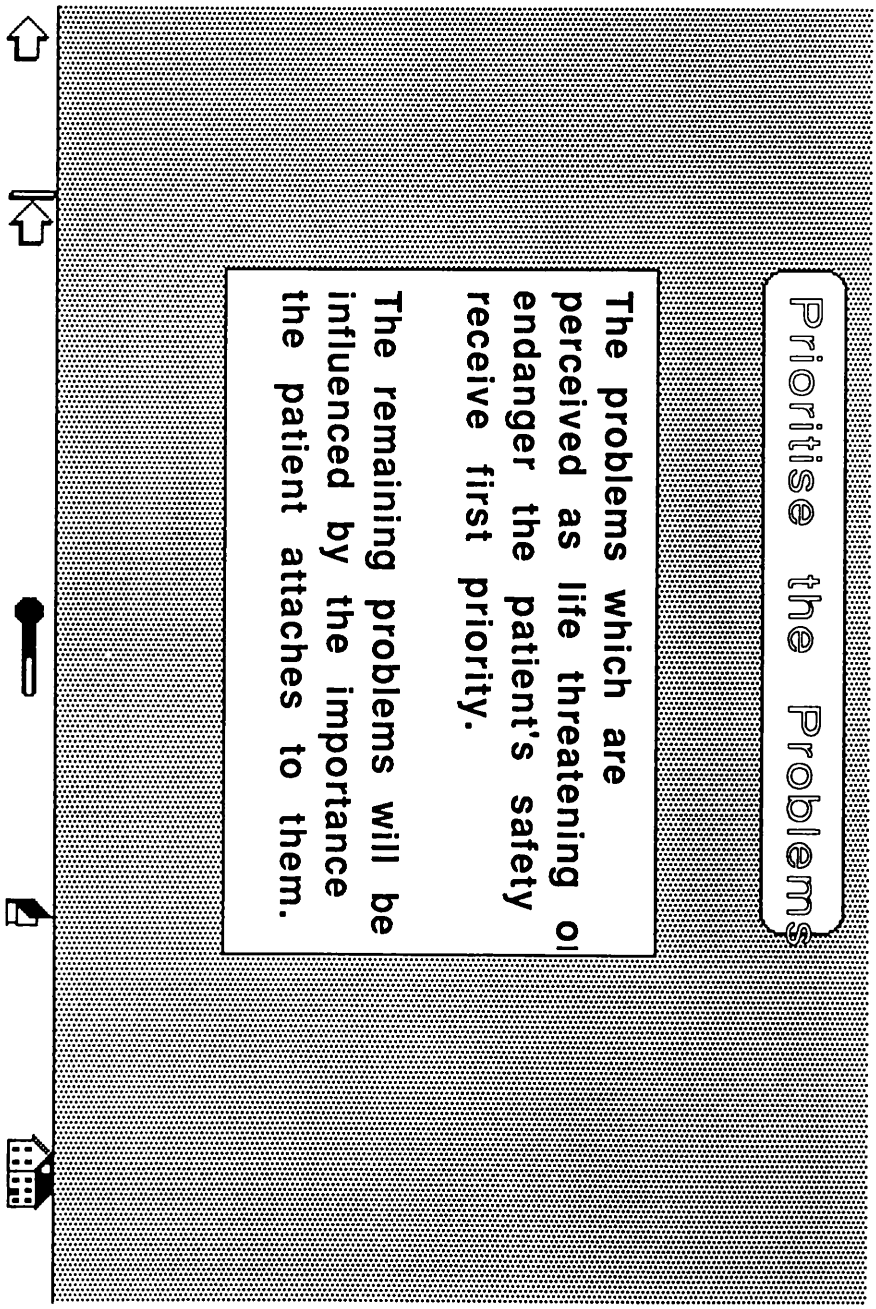
Your assessment of a patient's breathing is your first priority, life cannot be sustained without this activity. The assessment of your patient will build up below.

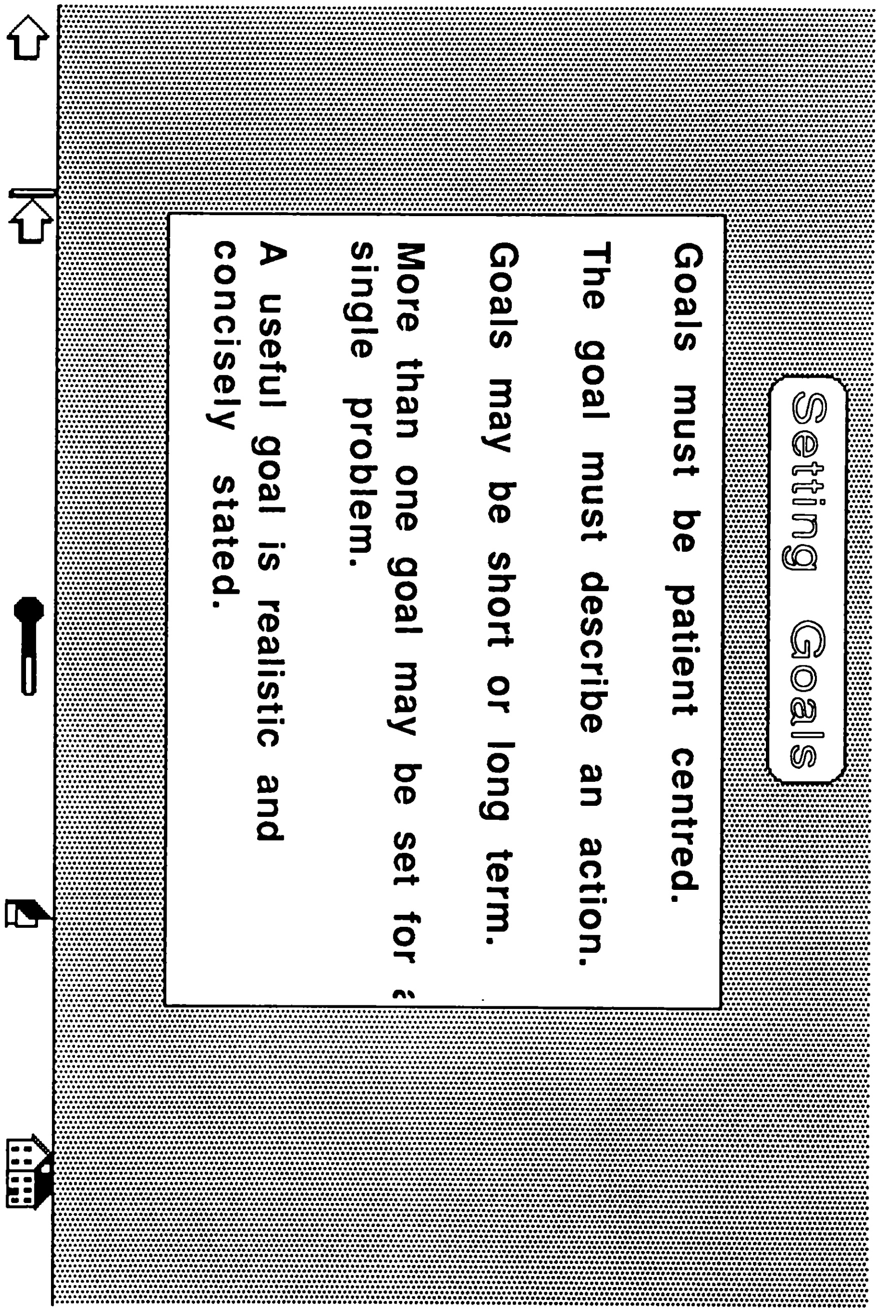
The Assessment of Mr McTaggart reveals that he is :-

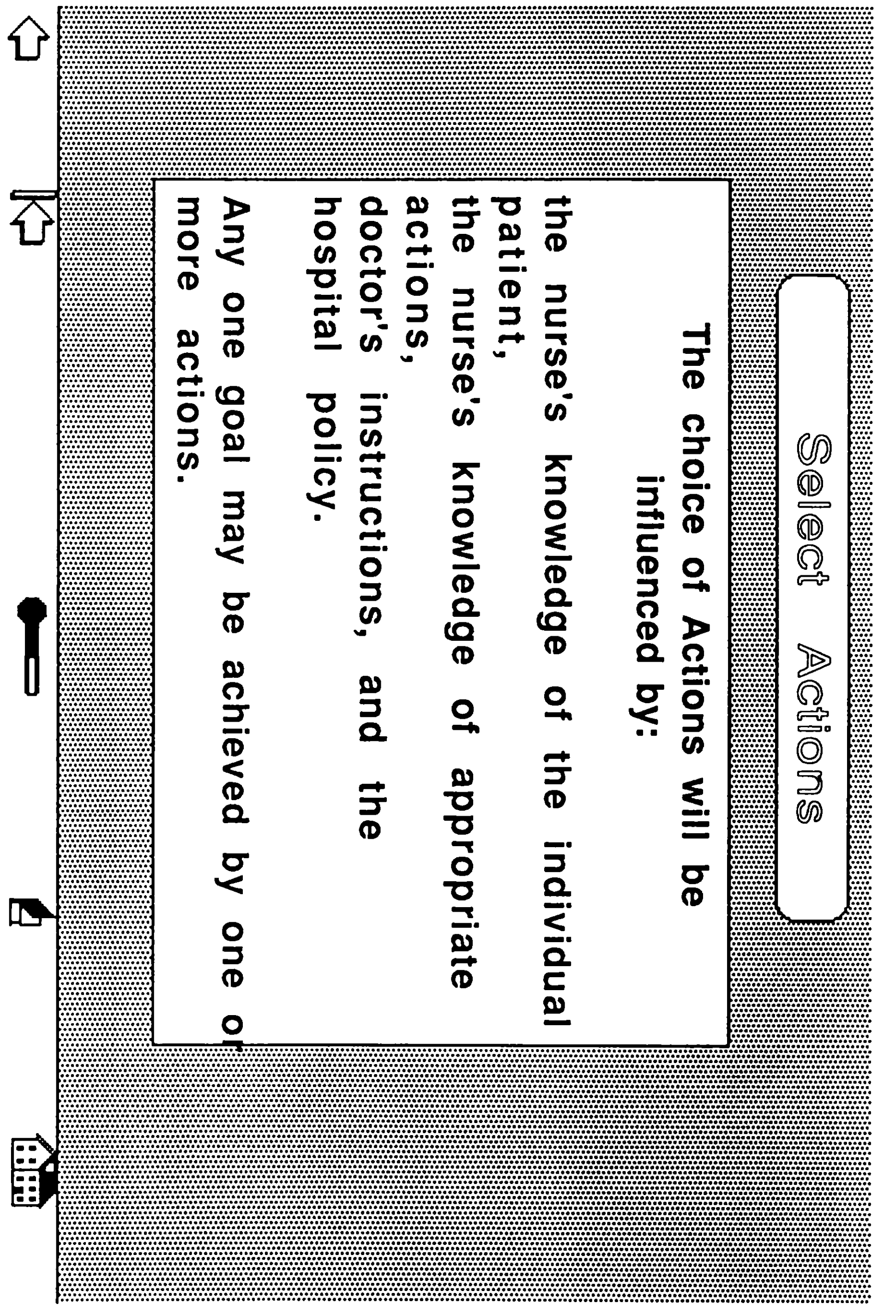
Click on this text for more information

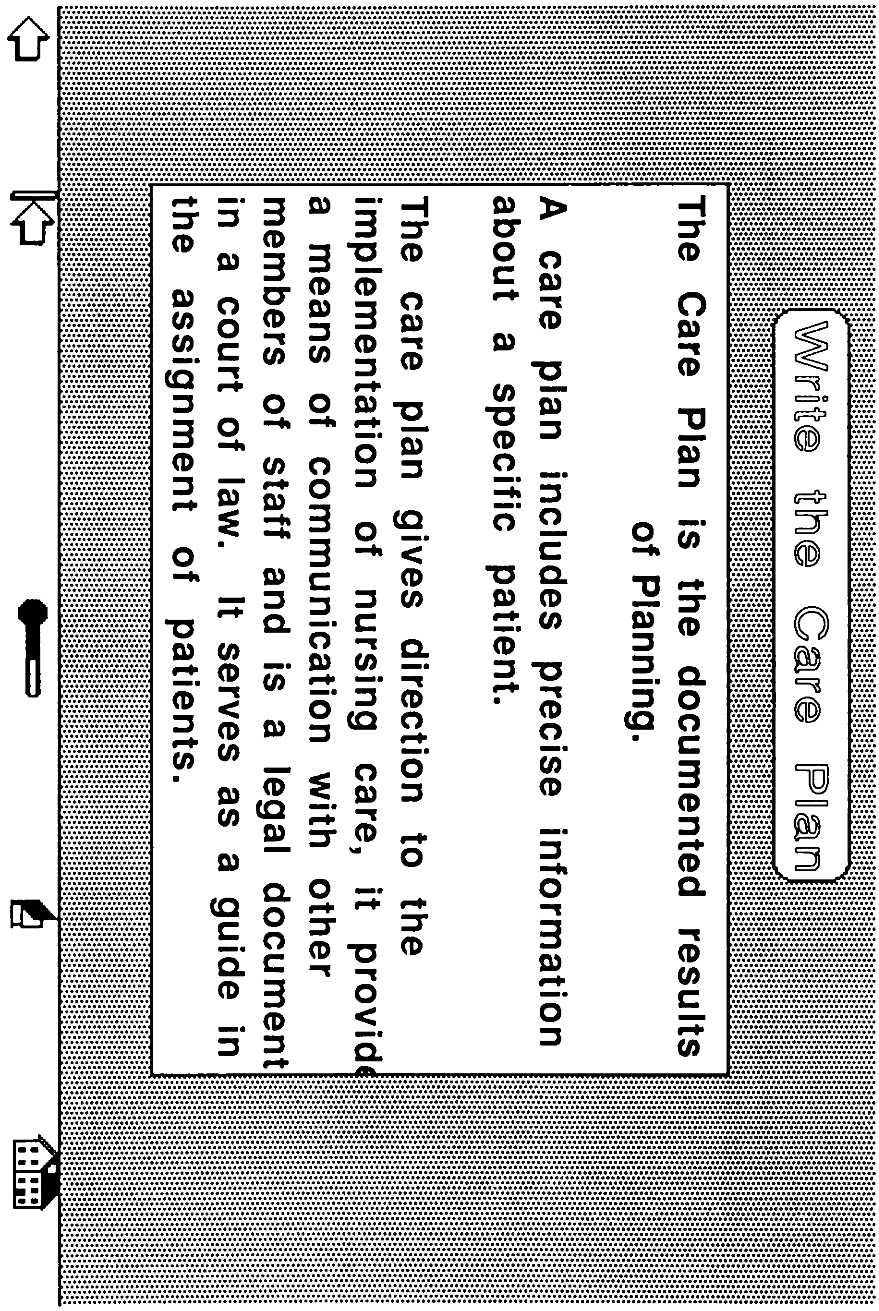

Assessment of the Activity of Living
Breathing
Mr James McTaggart
68yrs
Id. 732165
The Assessment of Mr McTaggart reveals that he is :-
the Problems identified are:-
Breathless with mild exertion, he has a moist productive cough with green,tenacious sputum.
Infected sputum
Dyspnoea
Cough


Planning Stage in more Detai
Careful Planning is now required to meet each patient's problems.
There are 4 steps involved in Planning:
1. PRIORITISE problems identified
2. SET GOALS for each problem
3. Select appropriate ACTIONS
4. Write the CARE PLAN
Click over the terms in upper case to have them explained more fully.


Prioritise the Problems
The problems which are perceived as life threatening or endanger the patient's safety receive first priority.
The remaining problems will be influenced by the importance the patient attaches to them.


Setting Goals
Goals must be patient centred.
The goal must describe an action.
Goals may be short or long term.
More than one goal may be set for
single problem.
A useful goal is realistic and
concisely stated.


Select Actions
The choice of Actions will be influenced by:
the nurse's knowledge of the individual patient,
the nurse's knowledge of appropriate actions,
doctor's instructions, and the hospital policy.
Any one goal may be achieved by one or more actions.


Write the Care Plan
The Care Plan is the documented results of Planning.
A care plan includes precise information about a specific patient.
The care plan gives direction to the implementation of nursing care, it provide
a means of communication with other members of staff and is a legal document in a court of law. It serves as a guide in the assignment of patients.

Care Plan -

In relation to the Assessment of Mr McTaggart's Breathing, the problems will be listed in order of priority, a goal will be identified for each problem and a plan of action decided upon to meet each goal. As you follow the instructions, the form will build up below.

Problems

click over this text to build up the form

Care Plan -

In relation to the Assessment of Mr McTaggart's Breathing, the problems will be listed in order of priority, a goal will be identified for each problem and a plan of action decided upon to meet each goal. As you follow the instructions, the form will build up below.

Problems	Goals / Aims	Plan of Actions
Dyspnoea	Mr McTaggart's dyspnoea will be alleviated	position upright, well supported with pillows;

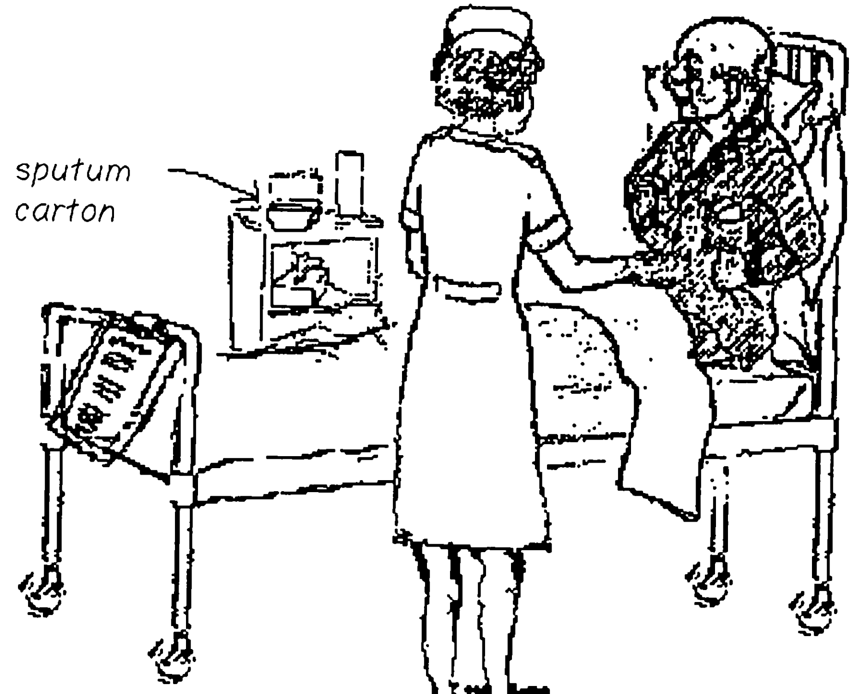
click over this text to list the second problem

Care Plan - example

Mr James McTaggart **68yrs** **Id. 732165**

Problems	Goals / Aims	Plan of Actions
Dyspnoea	Mr McTaggart's dyspnoea will be alleviated	position upright, well supported with pillows;
Cough	the accumulation of Mr McTaggart's secretions will be prevented	support chest during coughing spasms, encourage deep breathing, and expectoration;
Infected sputum	Mr McTaggart will have an infection free respiratory tract	chest physiotherapy, obtain specimen of sputum for culture and sensitivity with Dr's consent.

Implementation Stage in more Detail



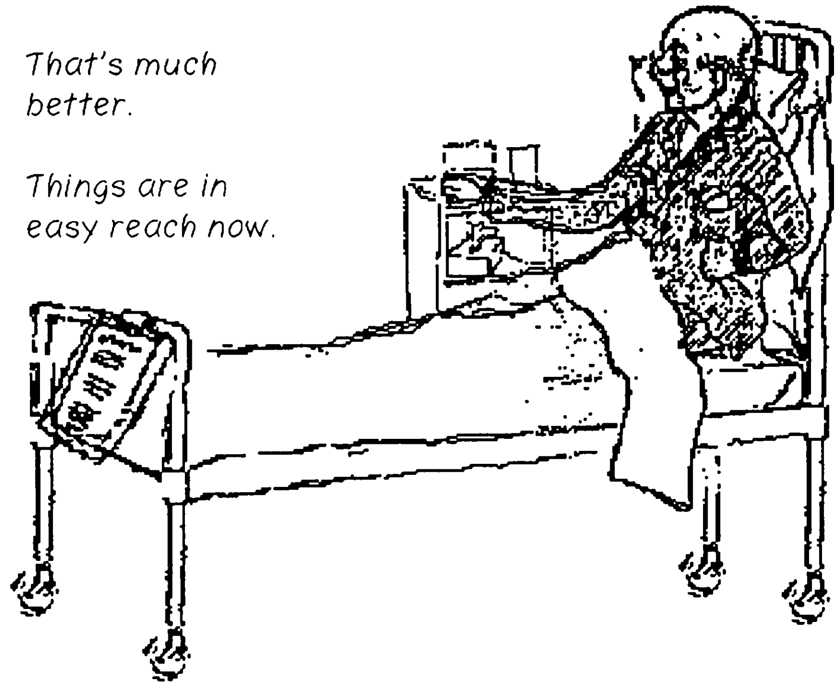
The pillows are arranged to support Mr McTaggart in an upright position.

The nurse is encouraging him to take deep breaths, cough and expectorate.

Implementation Stage in more Detail

That's much
better.

Things are in
easy reach now.



Evaluation Stage in more Detail

The evaluation stage of the Nursing Process identifies the extent to which the patient goals have been met by the nursing actions planned and implemented. We will look at the evaluation of Mr Mctaggart's Breathing. As you follow the instructions the form will build up below.

PROBLEMS

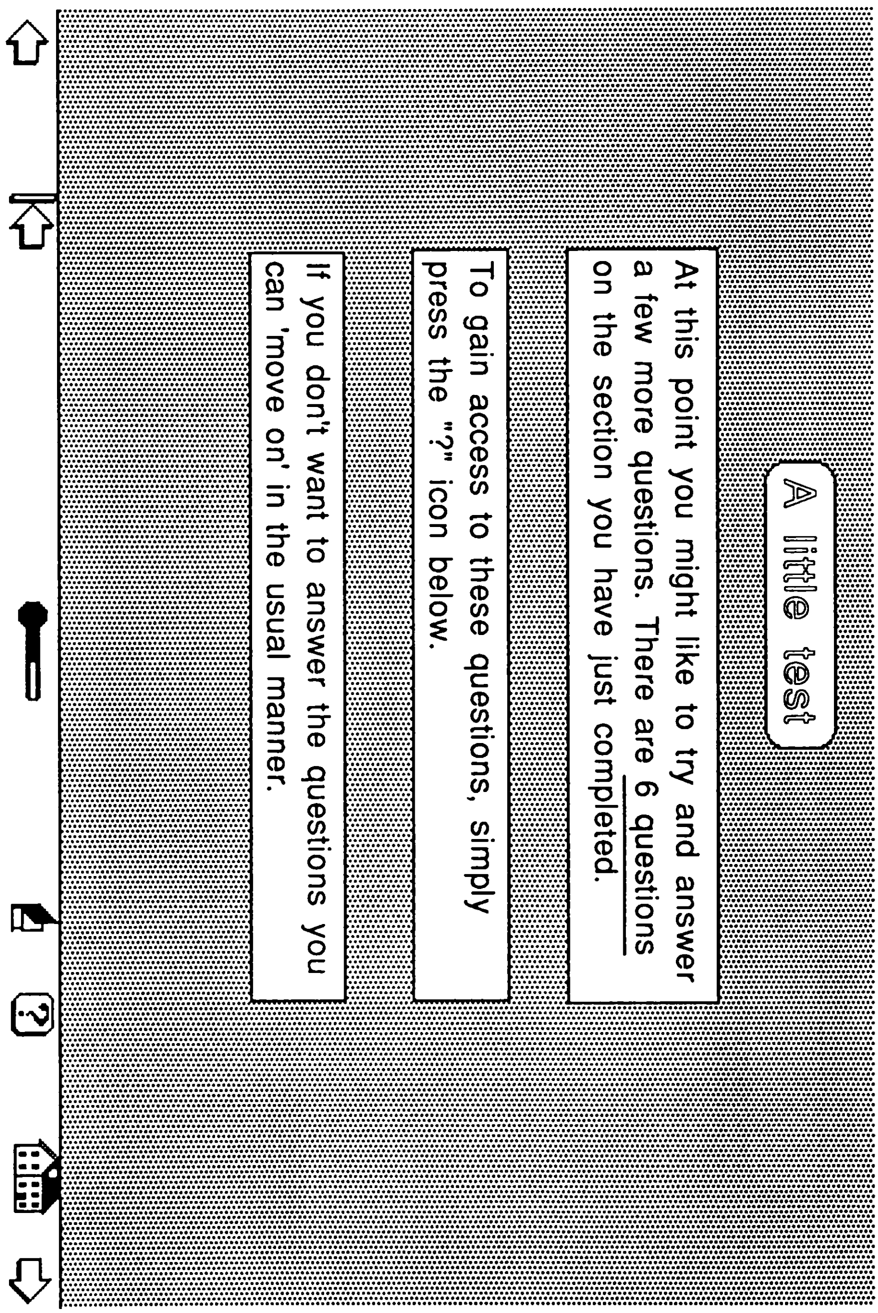
Click on this text to build up the form.

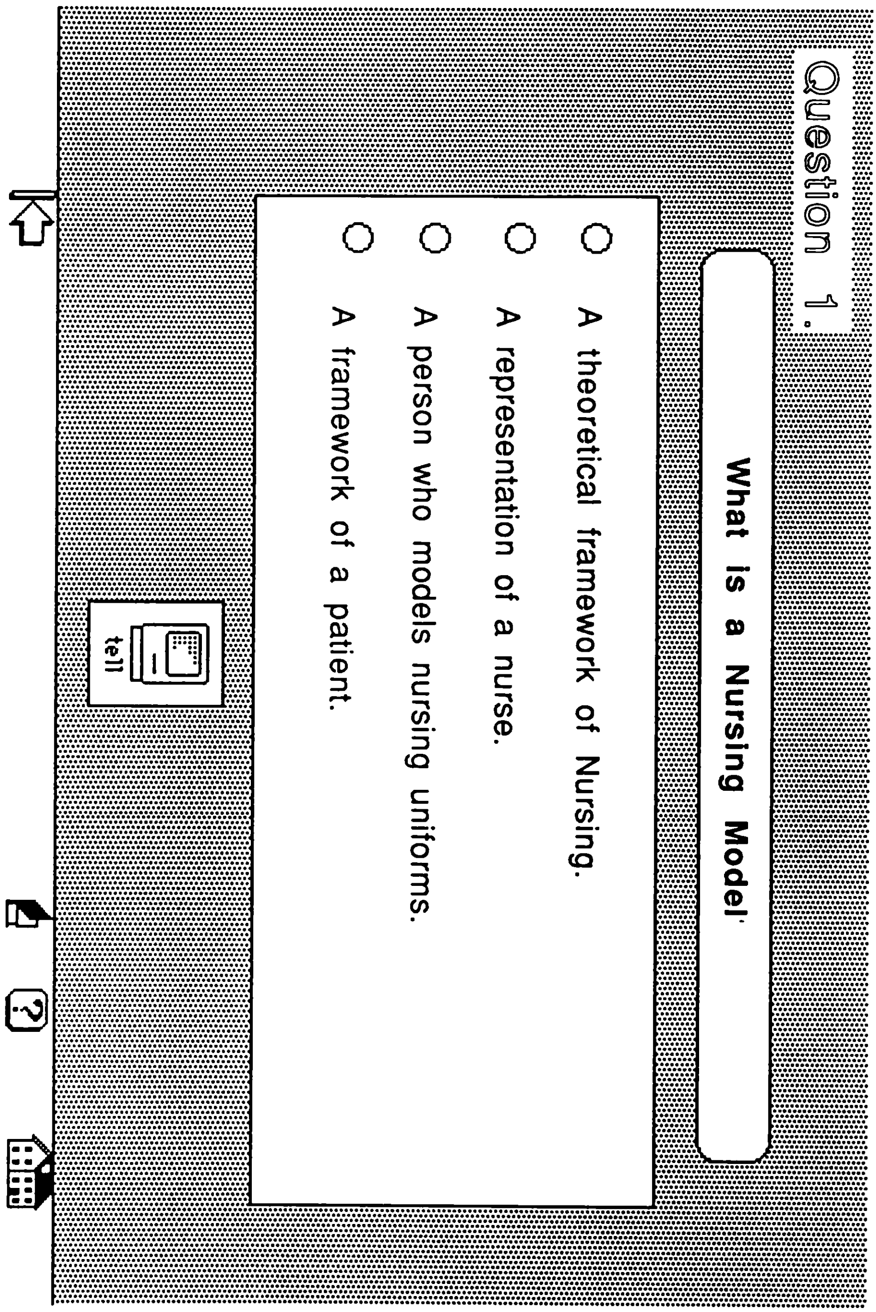
Evaluation Stage in more Detail

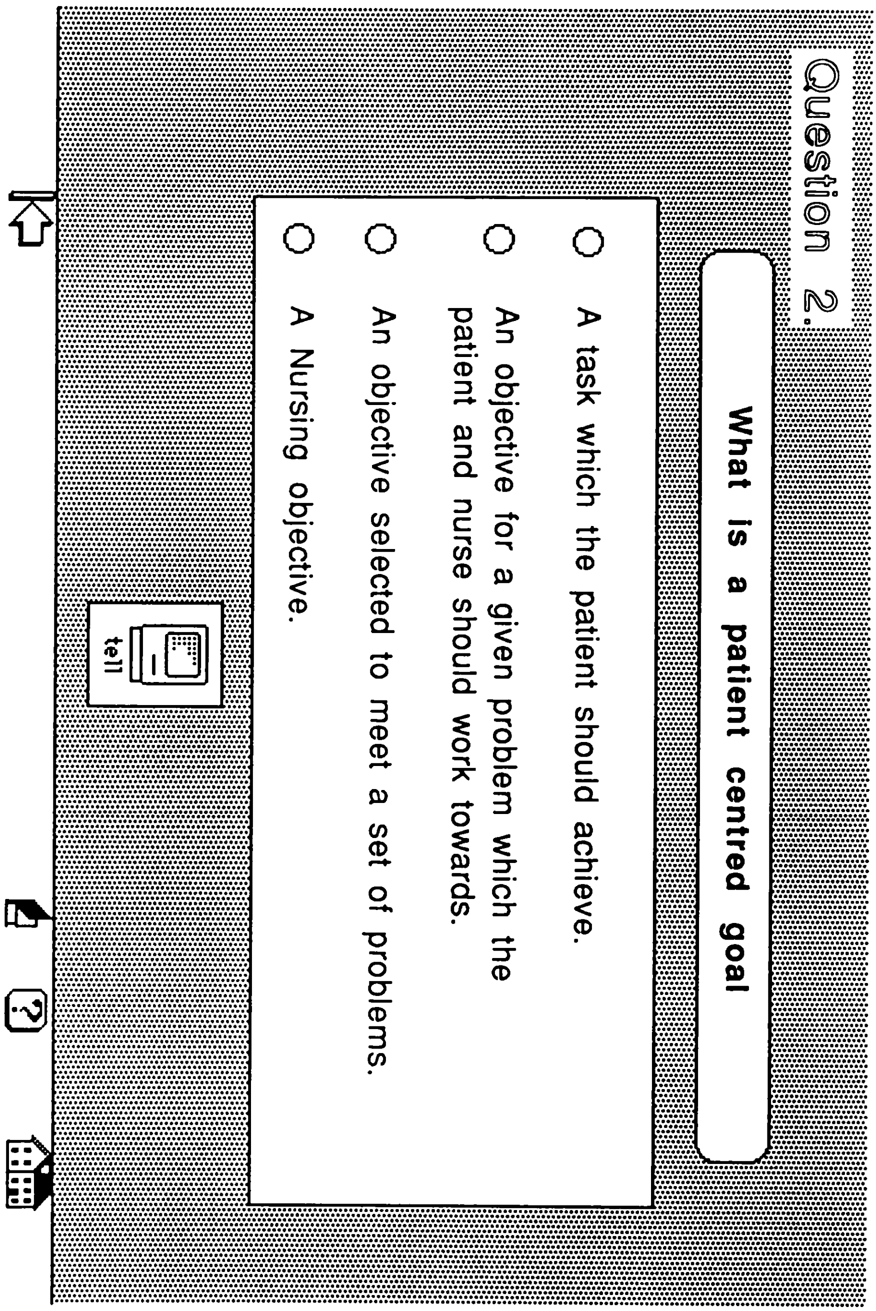
Mr James McTaggart 68yrs Id. 732165

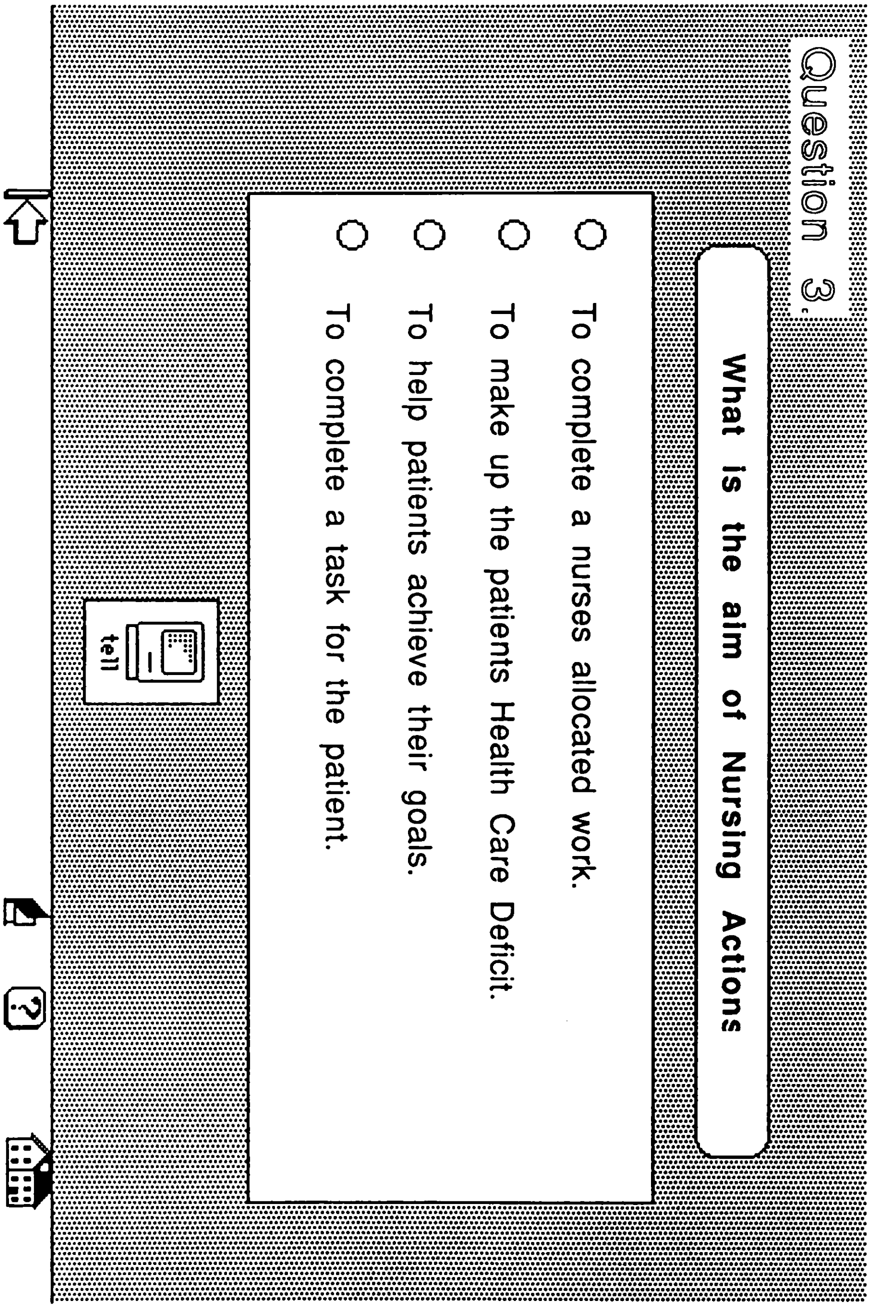
PROBLEMS	GOALS	Plan of Action	EVALUATION
Dyspnoea	Mr McTaggart's dyspnoea will be alleviated	position upright, well supported with pillows;	dyspnoea relieved when upright;
Cough	the accumulation of Mr McTaggart's secretions will be prevented	support chest during coughing spasms, encourage deep breathing and expectoration;	continues to have coughing spasms and expectorating green, tenacious sputum;
Infected sputum	Mr McTaggart will have an infection free respiratory tract	chest physiotherapy, obtain specimen of sputum for culture & sensitivity with Dr's consent.	specimen obtained, awaiting results. *Date and sign*

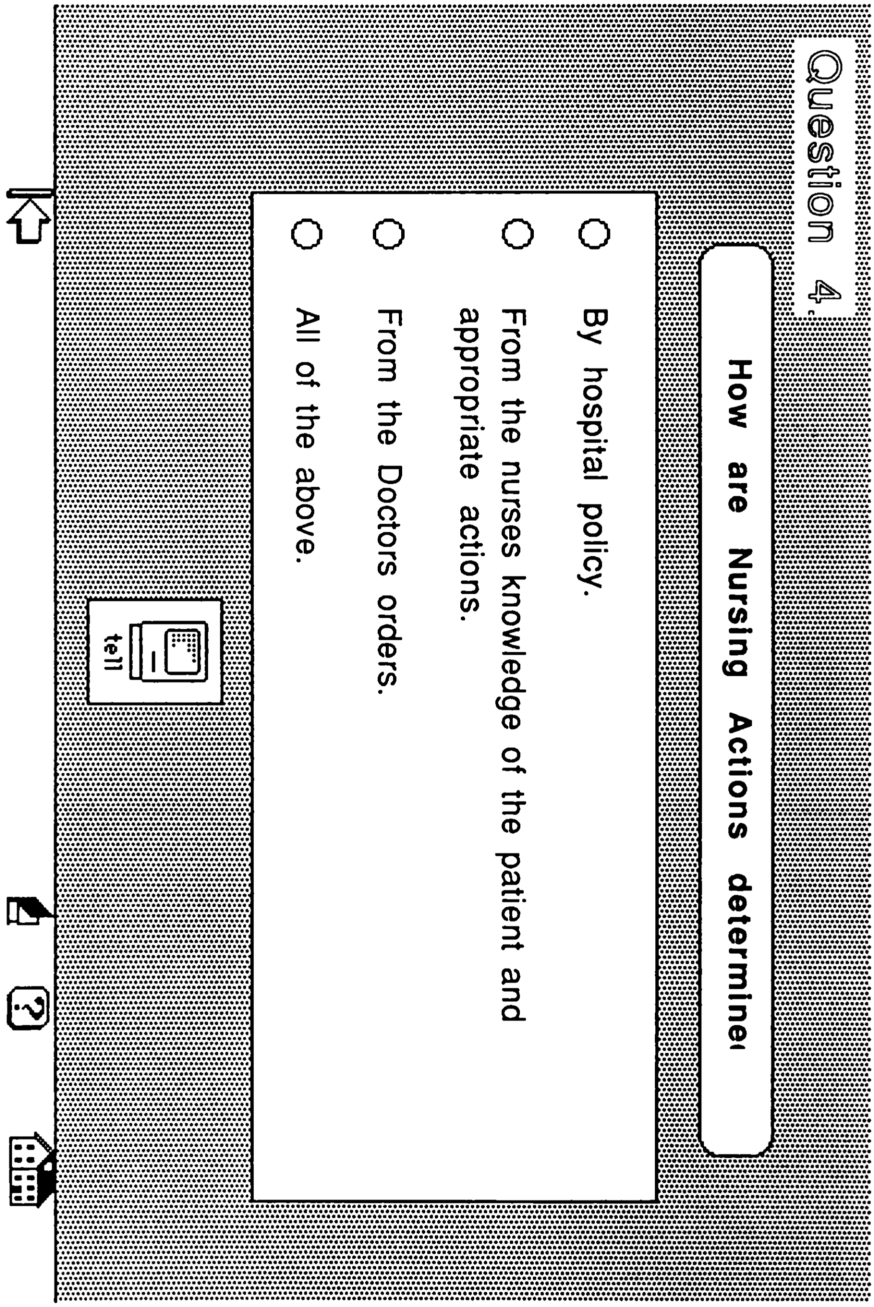
Remember, it is on the basis of the evaluation that planned nursing actions are maintained, modified or replaced. For an example, click on this text and HOLD MOUSE BUTTON DOWN.

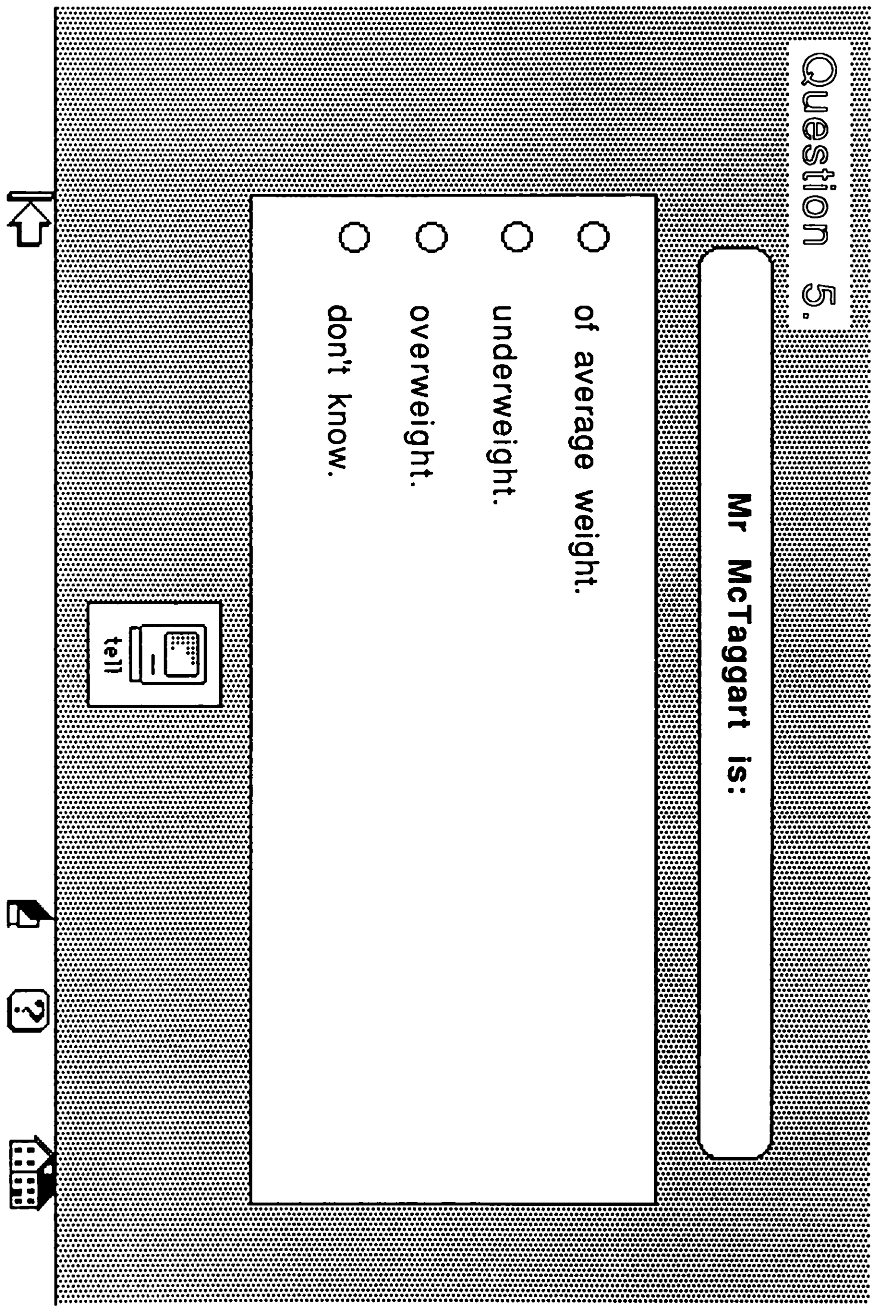

A little test
At this point you might like to try and answer a few more questions. There are 6 questions on the section you have just completed.
To gain access to these questions, simply press the "?" icon below.
If you don't want to answer the questions you can 'move on' in the usual manner.


Question 1.
What is a Nursing Model
A theoretical framework of Nursing.
A representation of a nurse.
A person who models nursing uniforms.
A framework of a patient.
tell

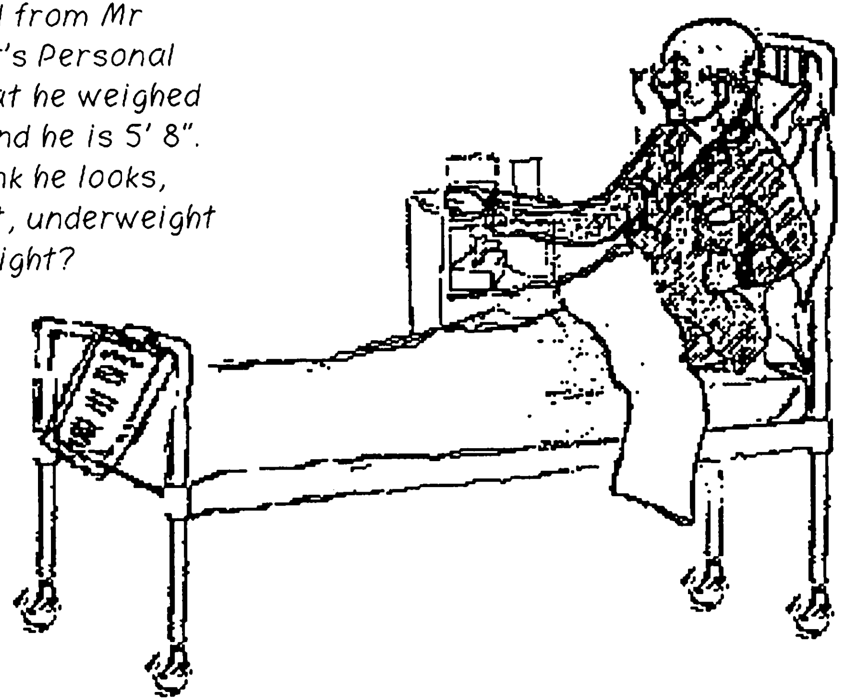

Question 2.
What is a patient centred goal
A task which the patient should achieve.
An objective for a given problem which the patient and nurse should work towards.
An objective selected to meet a set of problems.
A Nursing objective.
tell

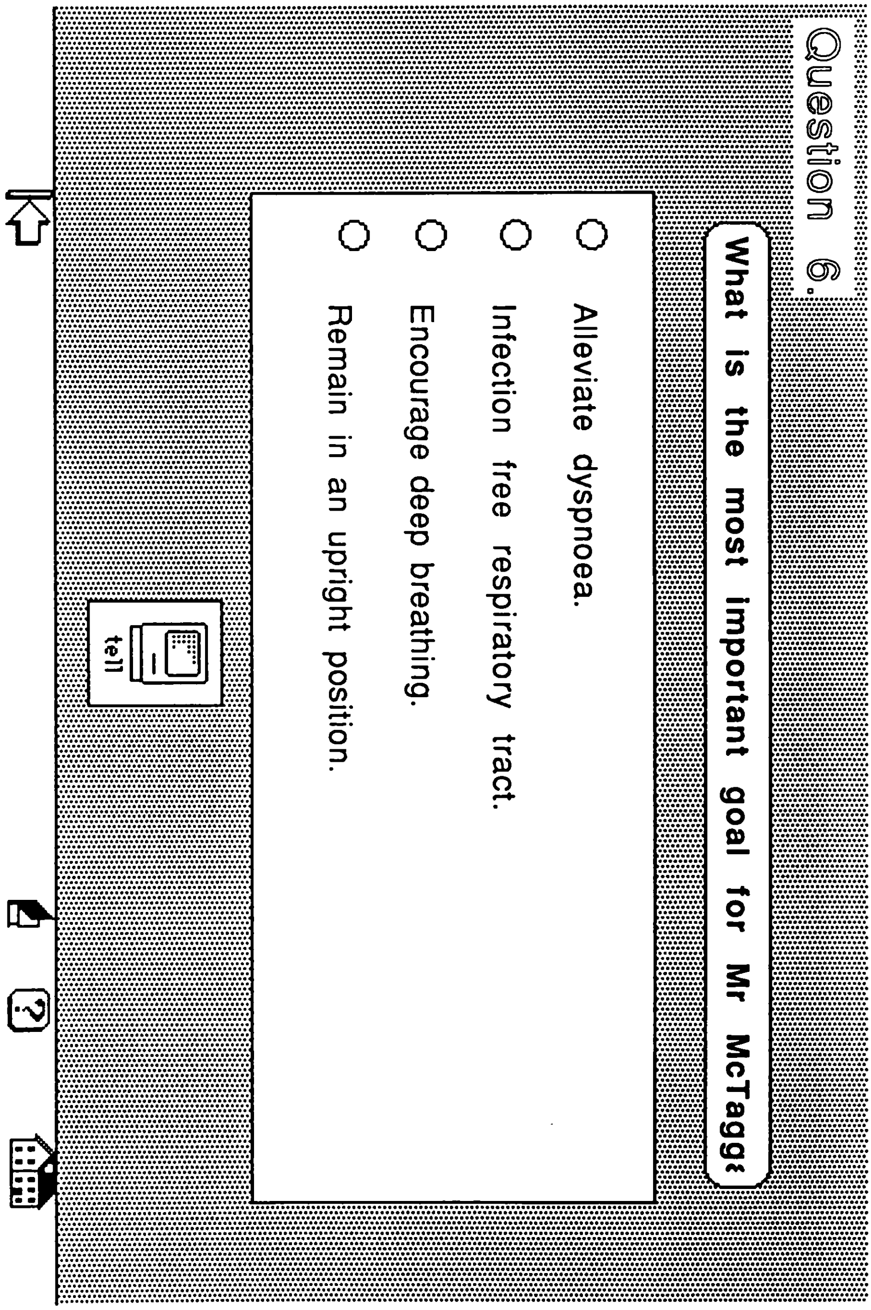

Question 3.
What is the aim of Nursing Actions
To complete a nurses allocated work.
To make up the patients Health Care Deficit.
To help patients achieve their goals.
To complete a task for the patient.
tell

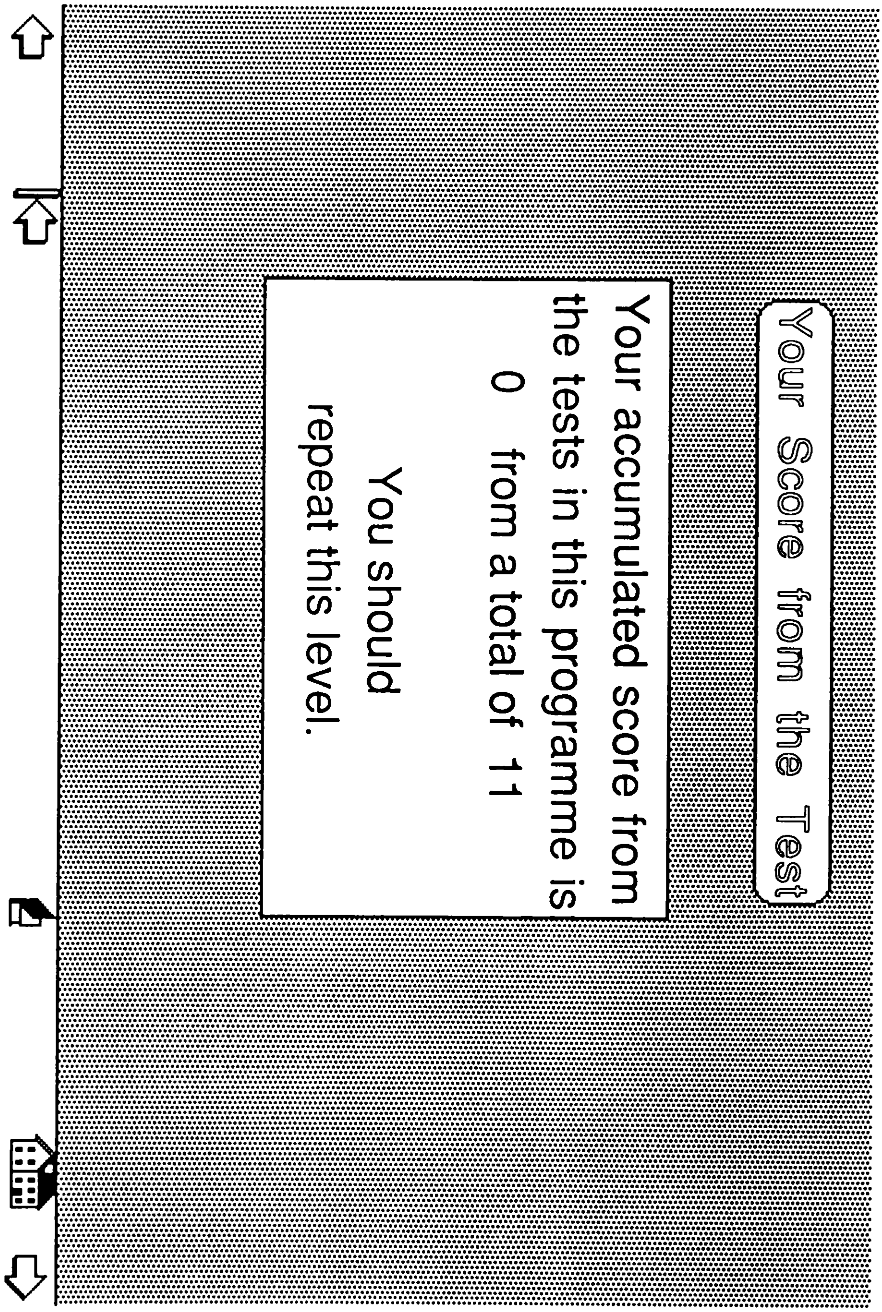

Question 4.
How are Nursing Actions determine
By hospital policy.
From the nurses knowledge of the patient and appropriate actions.
From the Doctors orders.
All of the above.
tell


Question 5.
Mr McTaggart is:
of average weight.
underweight.
overweight.
don't know.
tell

We learned from Mr McTaggart's Personal Details that he weighed 8st 7lbs and he is 5' 8". Do you think he looks, overweight, underweight or about right?




Question 6.
What is the most important goal for Mr McTaggt
Alleviate dyspnoea.
Infection free respiratory tract.
Encourage deep breathing.
Remain in an upright position.
tell


Your Score from the Test
Your accumulated score from the tests in this programme is
0 from a total of 11
You should repeat this level.

What has been Achieved?

The Beginner level has exposed you to information about the <u>concept</u>, and the <u>stages</u> of the Nursing Process. A simple example demonstrated how the Nursing Process can be <u>used</u> to organise Nursing care.

Use the Progress Thermometer to move to any of the sections in the programme which you may wish to revise.

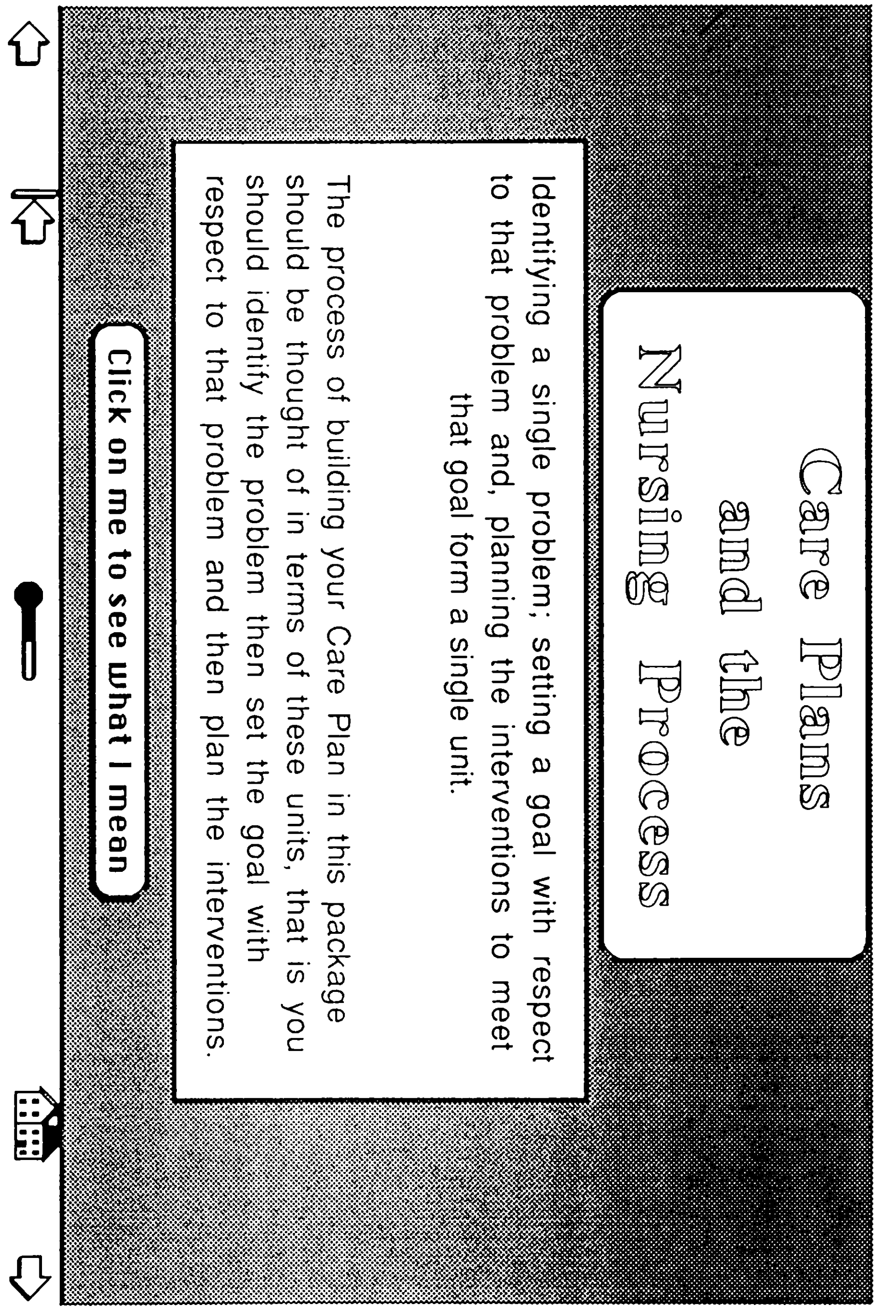
Nursing Process

Advanced Level

Welcome

You're now going to utilise your Computer-Use Skills and your knowledge fo the Nursing Process to build Care Plans on the computer!

Have fun!

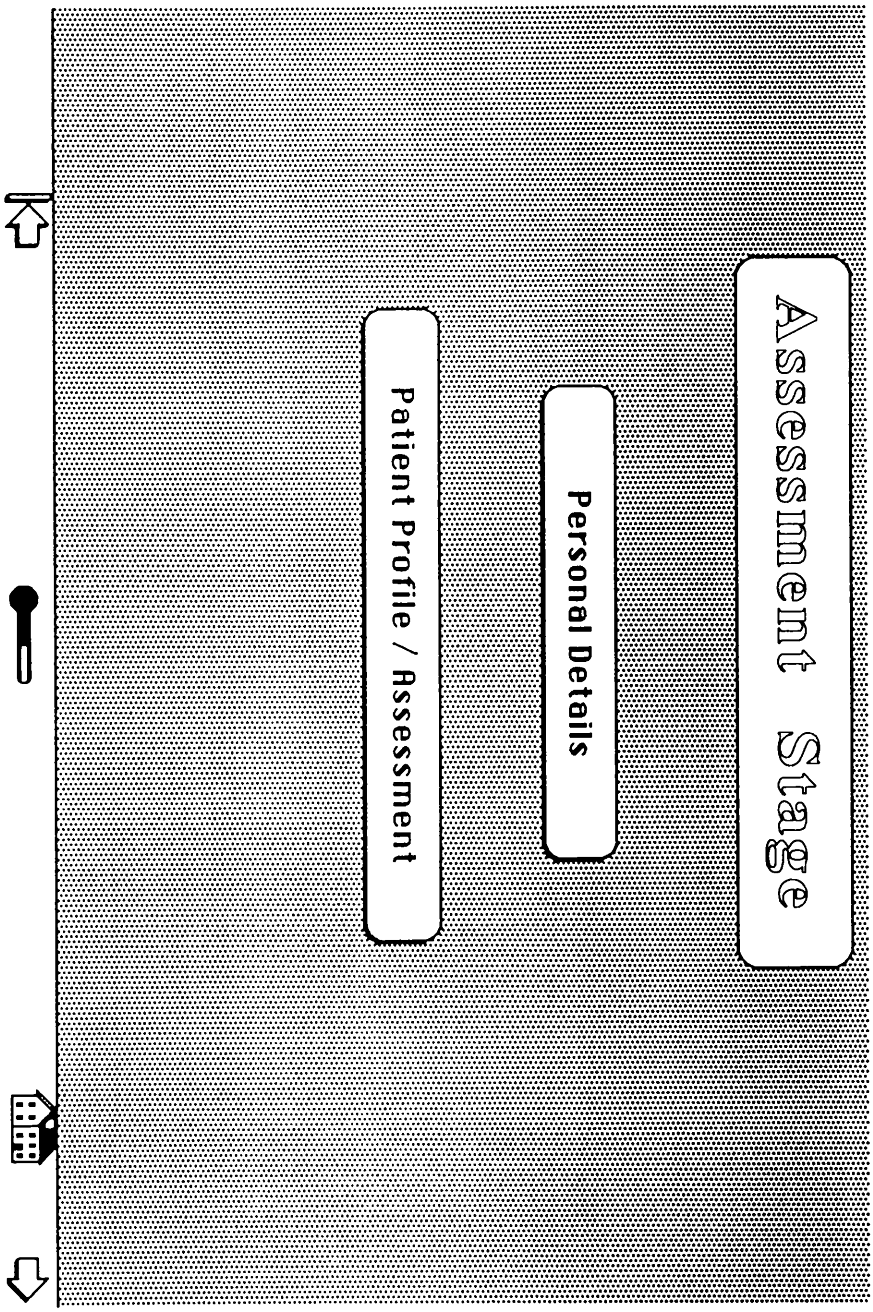

Care Plans
and the
Nursing Process
Identifying a single problem; setting a goal with respect to that problem and, planning the interventions to meet that goal form a single unit.
The process of building your Care Plan in this package should be thought of in terms of these units, that is you should identify the problem then set the goal with respect to that problem and then plan the interventions.
Click on me to see what I mean

Your First Patient

You can start off using this simulated Nursing Information System to help you plan the care of a patient who has fairly straightforward problems.

You will be introduced to the patients and their problems in a way very similar to that used in the Introductory Nursing Process Package.

When you have finished with this patient, you will be able to move on to patinets whose problems are not necessarly so straightforward.


Assessment Stage
Personal Details
Patient Profile / Assessment

Assessment Stage

Patient Profile / Assessment

Reason for Admission

Acute Appendicitis for surgery

Relevent past Medical History

Medical Diagnosis

Acute Appendicitis

Patient's Understanding of Health

Stomach Pain , sickness

Social History

Lives with parents

Weight *140lbs.* **Height** *5'6"*

You have been informed by the medical staff that John Taggart is going to be admitted as an Emergency with acute

Appendicitis

Appropriate analgesia with anti-emetic has been prescirbed.

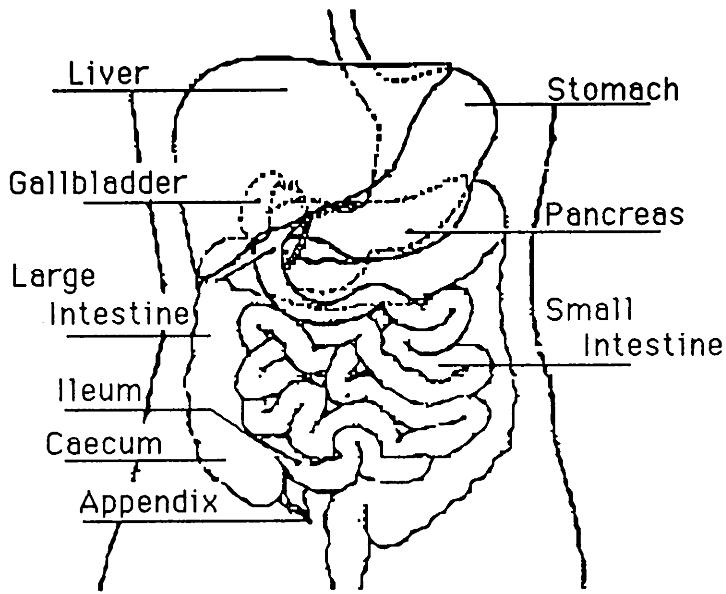
He is to be prepared for the operating theatre in 2-3 hours

Nursing Model

Appendicitis

is an inflammation of the appendix, a narrow blind end tube extending form the inferior part of the caecum. The most common cause of appendicitis is an obstruction of the lumen by faeces or scar tissue.

Abdominal Cavity



Can you identify the Appendix ?

Appendicitis may be complicated, eg. the adjacent bowel and omentum can adhere to the inflamed appendix forming an appendix abscess. There is also a risk that the appendix will rupture with an escape of organisms into the peritoneal cavity resulting in generalised peritonitis

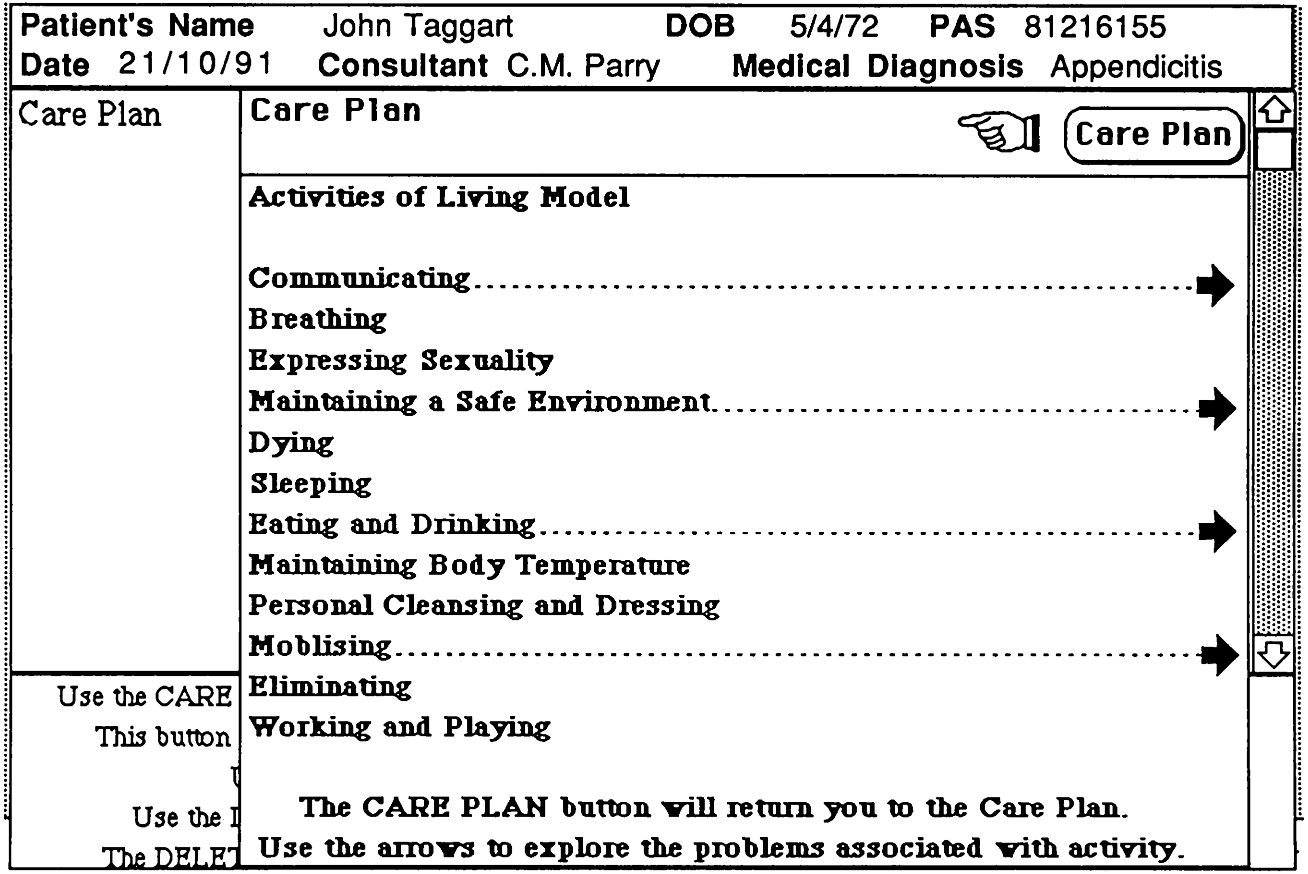
Prompt surgical intervention is required but only if the inflammation is localised to the appendix.

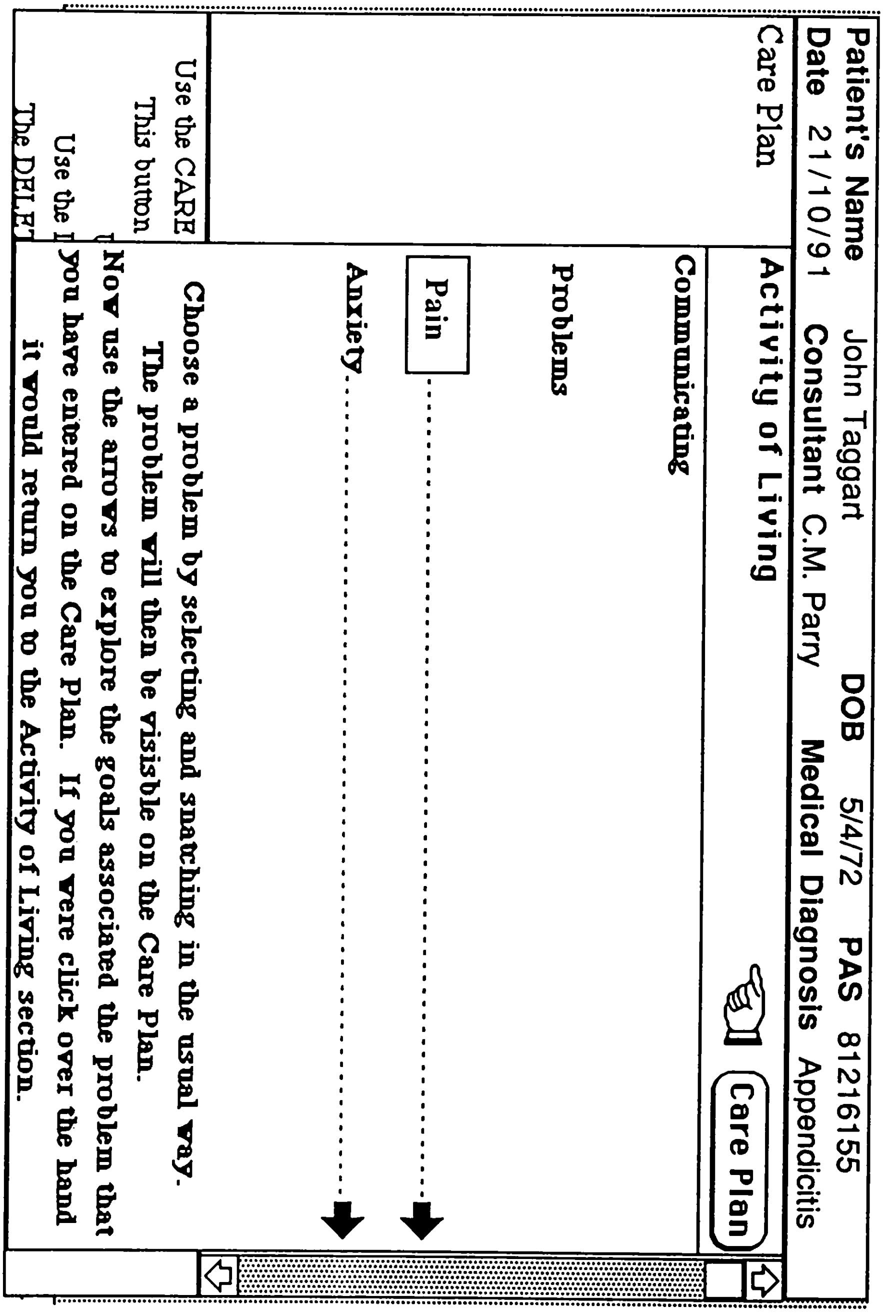
Planning Stage

Careful planning is now required to meet each of the patient's problems. Remember there are 4 steps involved in planning:

i) prioritise the problems
ii) set goals for each problem
iii) select appropriate interventions
iv) writing the care plan

You are now going to build a Care Plan


Patient's Name John Taggart DOB 5/4/72 PAS 81216155
Date 21/10/91 Consultant C.M. Parry Medical Diagnosis Appendicitis
Care Plan
Care Plan
Care Plan
Activities of Living Model
Communicating
Breathing
Expressing Sexuality
Maintaining a Safe Environment
Dying
Sleeping
Eating and Drinking
Maintaining Body Temperature
Personal Cleansing and Dressing
Moblising
Eliminating
Working and Playing
The CARE PLAN button will return you to the Care Plan.
Use the arrows to explore the problems associated with activity.


Patient's Name John Taggart DOB 5/4/72 PAS 81216155
Date 21/10/91 Consultant C.M. Parry Medical Diagnosis Appendicitis
Care Plan
Activity of Living
Care Plan
Communicating
Problems
Pain
Anxiety
Use the CARE
This button
Use the I
The DELET
Choose a problem by selecting and snatching in the usual way.
The problem will then be visible on the Care Plan.
Now use the arrows to explore the goals associated the problem that you have entered on the Care Plan. If you were click over the hand it would return you to the Activity of Living section.

Patient's Name John Taggart **DOB** 5/4/72 **PAS** 81216155
Date 21/10/91 **Consultant** C.M. Parry **Medical Diagnosis** Appendicitis

Care Plan Delete Care Library Done Review

Pain
The patient will communicate verbally and non-verbally
that his pain is under control 48 hours
Patient will be given intra-muscular analgesia as prescribed
The patient will be assessed within 30 minutes of having been
given analgesia to ensure it has had the desired effect

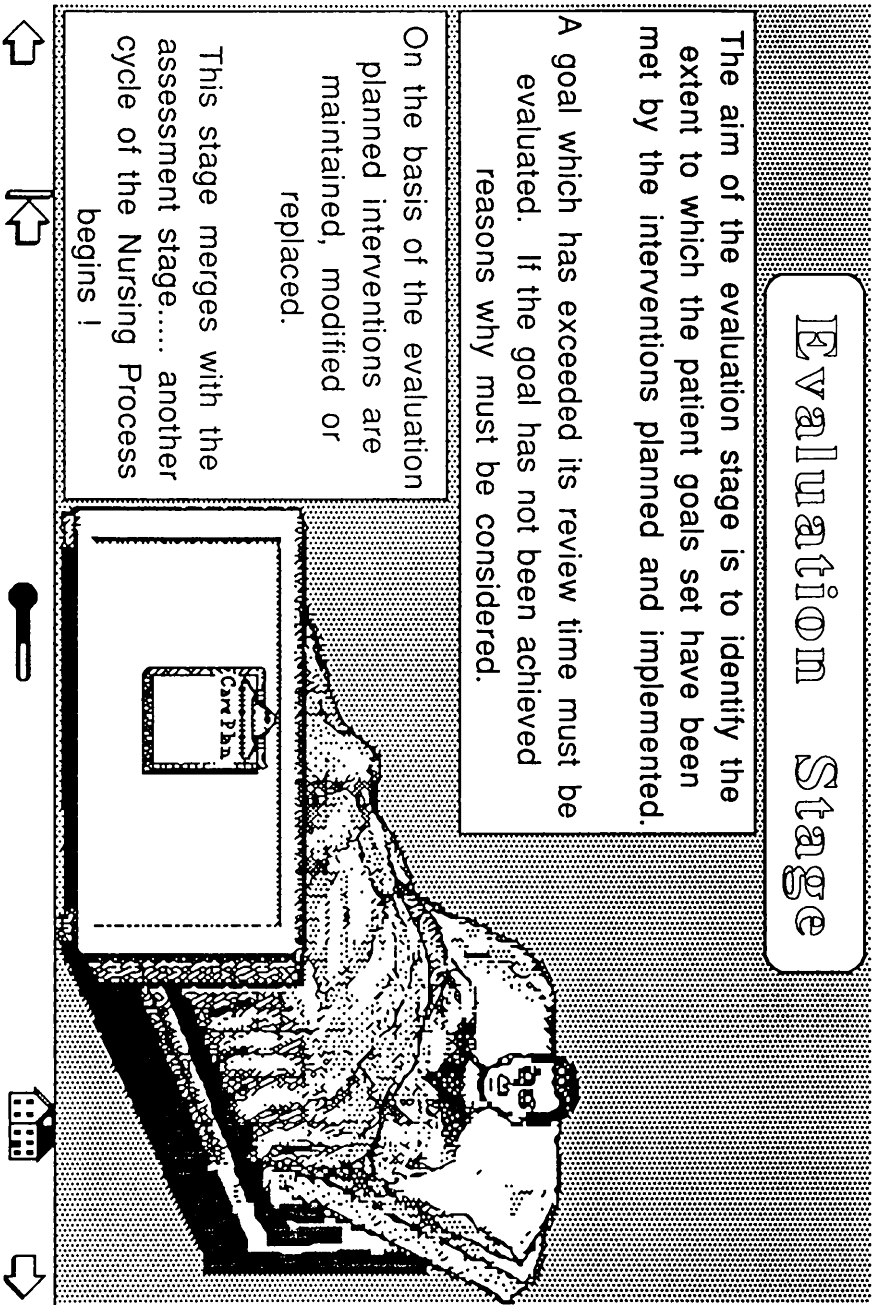
Use the CARE LIBRARY button to take you into the information for building up the Care Plan.
This button will also return you to that section of Care Plan building that you came from.
Use the scroll bar at the side if your plan covers more than 1 page.
Use the DONE button once you have completed your Care Plan to your satsfaction.
The DELETE button will erase all the informationon your Care Plan so use this carefully.

Implementation Stage

John Taggart's pre-operative care was successfully completed . He was transferred to the operating theatre 3 hours after admission, where an **appendicectomy** was performed. John has a small suture line about 5-7cms. long covered with an airsrip dressing. His recovery from anaesthesia was uneventful.

John has returned to your care post-operatively.
You are now going to complete the final stage of the Nursing Process and review the Care Plan set pre-operatively.

You will be presented with an illustrative example of his pre-operative Care Plan which you can use to both compare with the care plan you set at the planning stage and you will be required to evaluate the Plan whilst considering his care for the next 24 hours.


Evaluation Stage
The aim of the evaluation stage is to identify the extent to which the patient goals set have been met by the interventions planned and implemented.
A goal which has exceeded its review time must be evaluated. If the goal has not been achieved reasons why must be considered.
On the basis of the evaluation planned interventions are maintained, modified or replaced.
This stage merges with the assessment stage..... another cycle of the Nursing Process begins !
Care Plan

Patient's Name John Taggart **DOB** 5/4/72 **PAS** 81216155
Date 21/10/91 **Consultant** C.M Parry **Medical Diagnosis** Appendicectomy

CARE PLAN (example)	Review
PAIN	
The patient will communicate verbally and non-verbally that his pain is under control	48 hours
Patient will be given intra-muscular analgesia as prescribed	
The patient will be assessed within 30 minutes of having been given analgesia to ensure it has had the desired effect	
NAUSEA and VOMITING	
Patient will not be nauseated and cease vomiting	48 hours
Patient will have nil orally	12 hours
Patient will have a vomit bowl within easy reach, contents will be observed and emptied as required	
Patient will recieve intra-muscular anti-emetic as prescribed	
It will be clearly indicated at the patient's bedside that he is fasting for theatre.	

Click over the Review time to evaluate a Goal. Scroll down

Move to the next page by clicking over the scroll down button

Patient's Name
Date 21/10/91 C

PAIN
The patient will co
his pain is under c
Patient will be g
The patient will
given analgesia

NAUSEA and VOM
Patient will not be
Patient will have
and emptied as re
Patient will recie

ANXIETY
Patient will have t

Click over the C

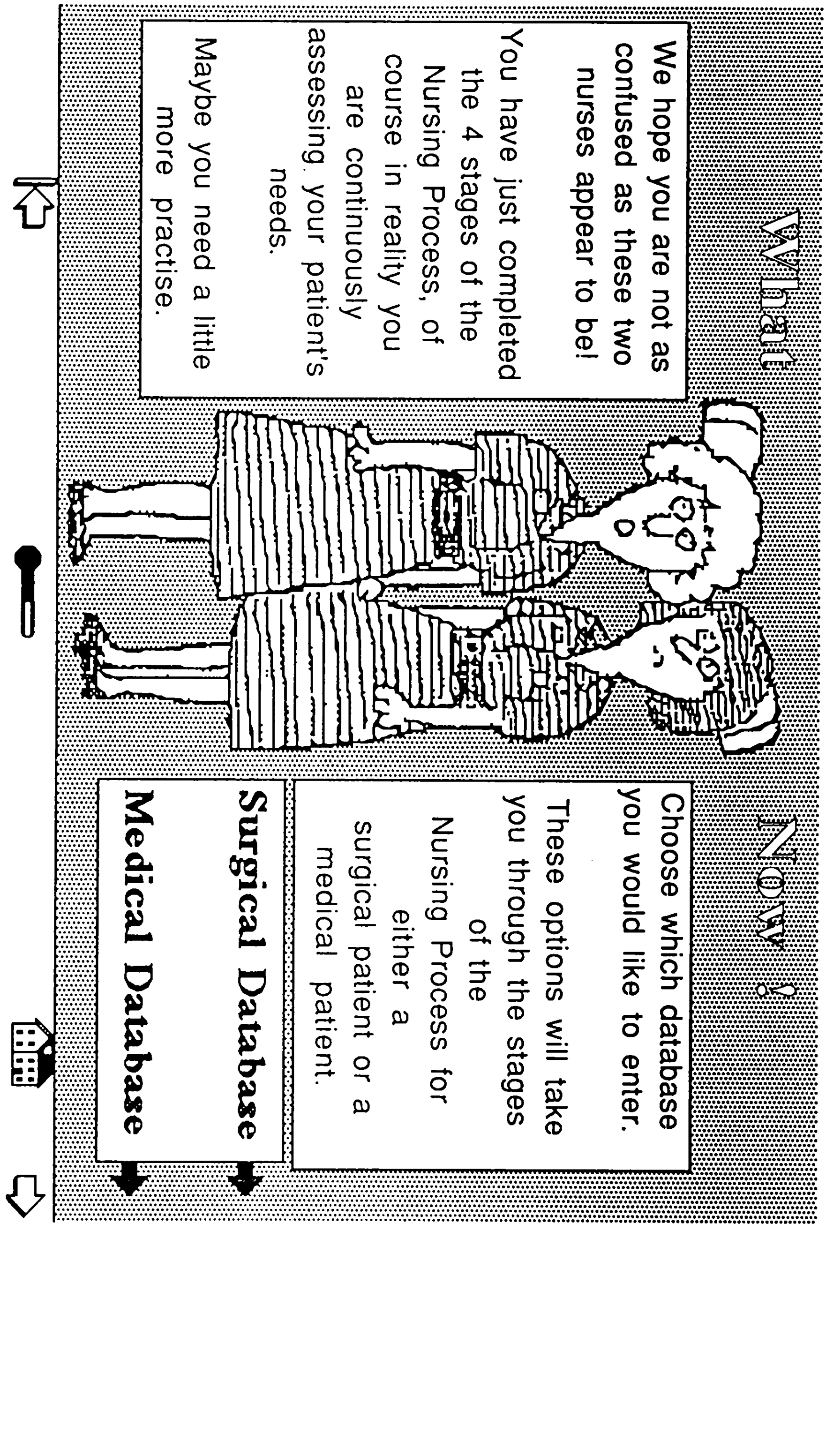
SUMMARY

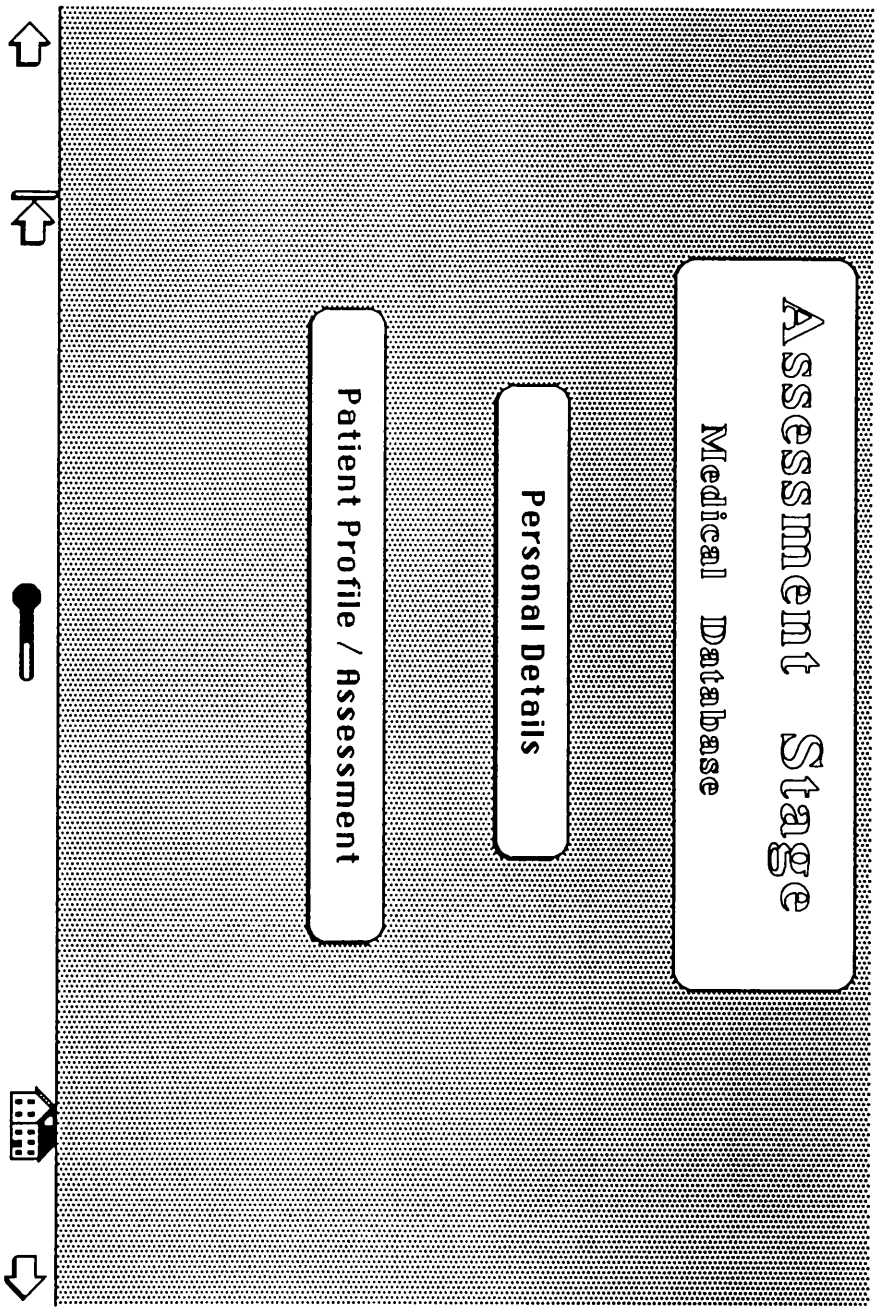
You are now left with an incomplete care plan.

Of the problems originally identified only 3 remain.
PAIN continues to be a problem and the goal remains the same as do the interventions.
NAUSEA and VOMITING continues to be a problem one of the goals remains relevent but another goal for your patient may be to increase fluids as tolerated over the next 24 hours, new interventions should be set to meet this new goal.
ANXIETY remains a problem and the goal is still relevent but now John requires different information, the interventions should now include information relevent to his rehabilitation.

Your patient also has new problems which need to be addressed eg. the potential injury due to surgical intervention, wound infection. Having identified his problems you should now repeat the planning stage. You are now into the continuous cycle of the Nursing Process...........!

Click inside this box to hide it


What Now?
We hope you are not as confused as these two nurses appear to be!
You have just completed the 4 stages of the Nursing Process, of course in reality you are continuously assessing. your patient's needs.
Maybe you need a little more practise.
Choose which database you would like to enter.
These options will take you through the stages of the Nursing Process for either a surgical patient or a medical patient.
Surgical Database
Medical Database


Assessment Stage
Medical Database
Personal Details
Patient Profile / Assessment

Assessment Stage

Patient Profile / Assessment

Reason for Admission

Hyperglycaemia, Ketoacidosis

Relevent past Medical History

Insulin Dependent Diabetus Mellitus

Medical Diagnosis

Diabetic Ketoacidosis

Patient's Understanding of Health

Diabets unstable

Social History

Lives with wife

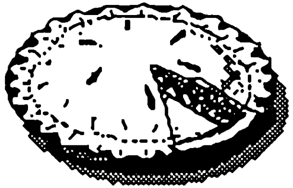
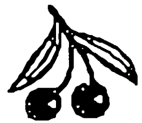
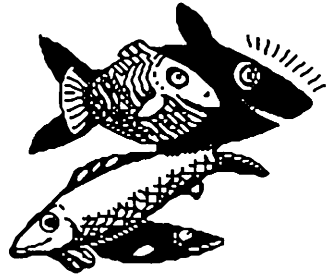
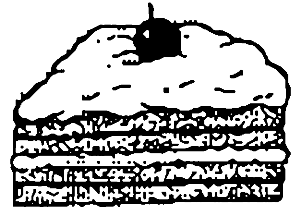
Weight *160lbs* **Height** *5'10""*

You have been informed by the Medical staff that Andrew Connelly is going to be admitted as an emergency with **Hyperglycaemia** and **Ketoacidosis**

His diabetes has been unstable for a few days.

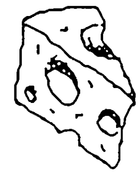
His blood sugar is elevated and his urine shows a high concentration of sugar and ketone bodies

Nursing Model

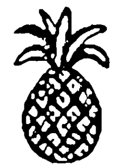





Diabetic Ketoacidosis

is a serious metabolic complication when there is too little insulin and an excess of glucose. The glucose in the blood cannot be utilised by the cells and fat is broken down to provide energy.



The breakdown of fats produces fatty acids and glycerol, fatty acids are broken down by the liver producing ketone acids which can be utilised by the cells. This process (ketogenesis) proceeds rapidly exceeding the rate at which the ketone acids are metabolised resulting in an accumulation of ketone acids or ketoacidosis in the blood.



This condition must be treated promptly to prevent the patient from becoming comatose as a result of falling blood pressure.

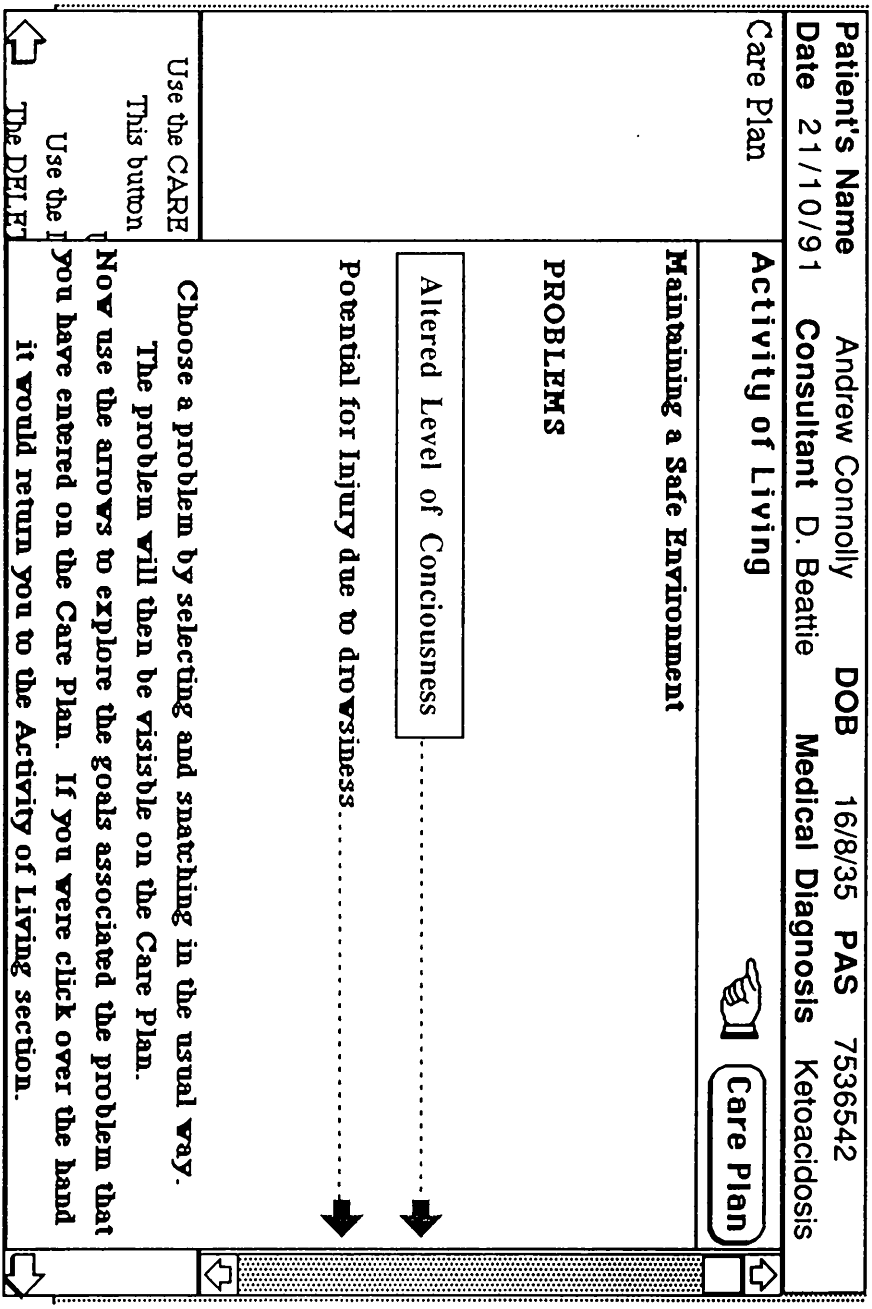
Planning Stage

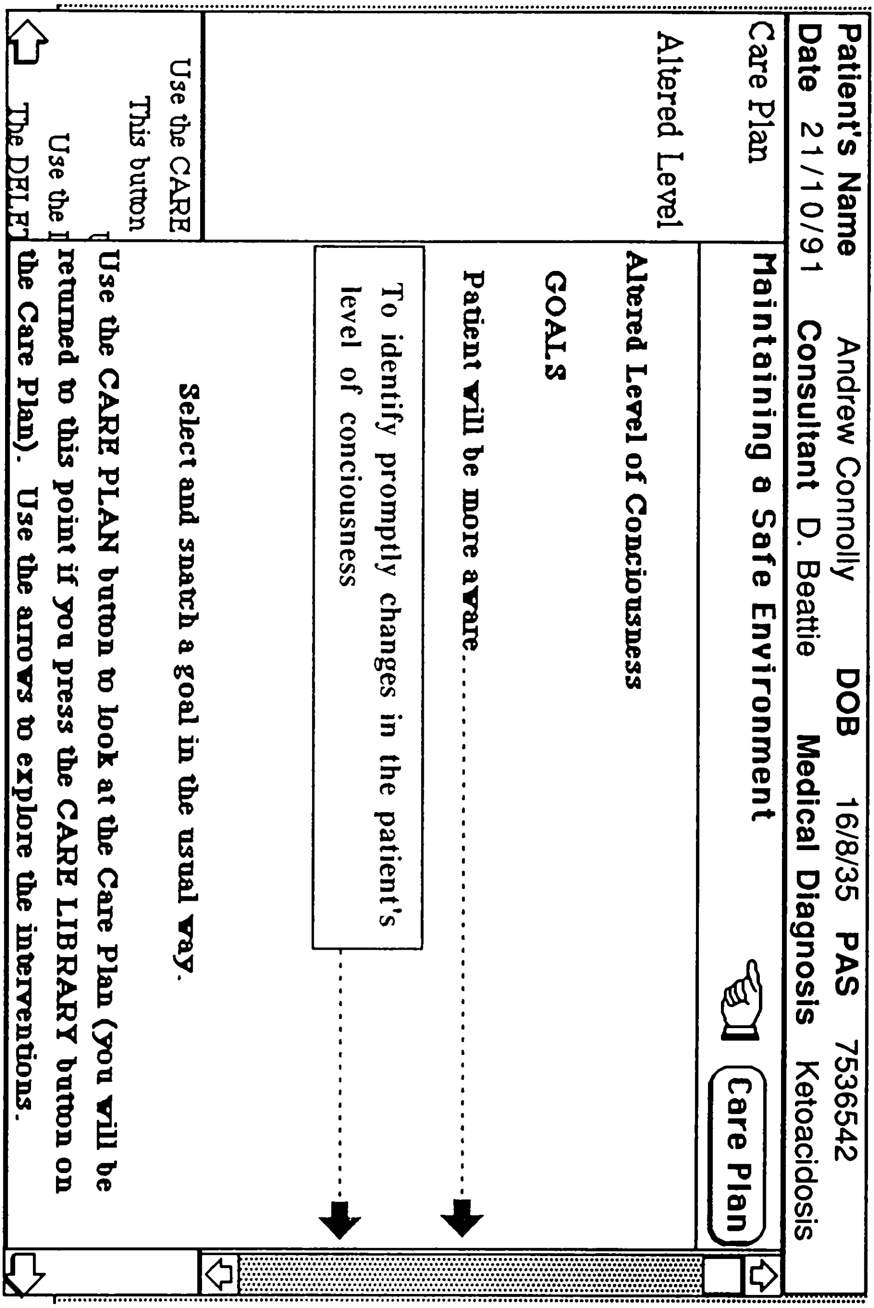
Medical Database

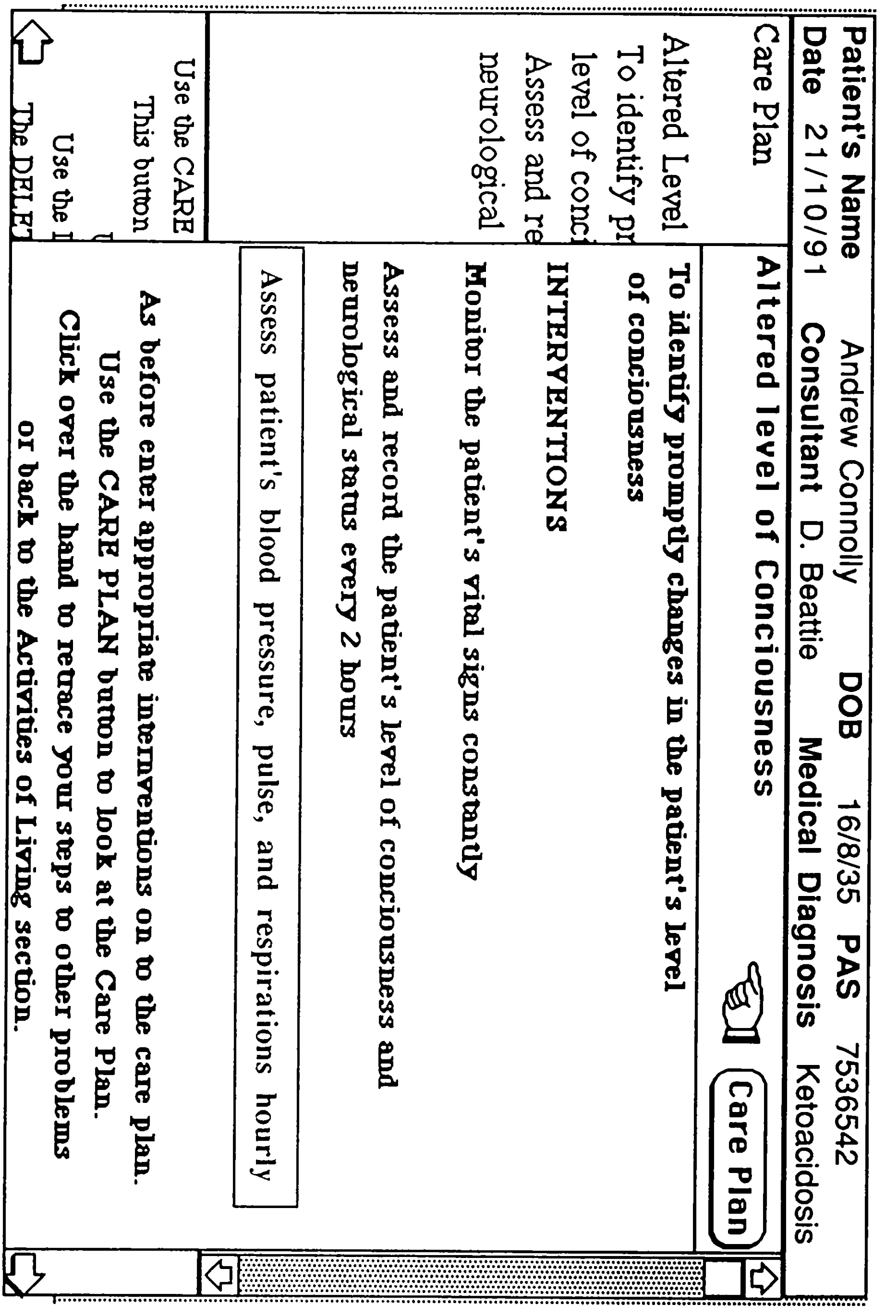
Careful planning is now required to meet each of the patient's problems. Remember there are 4 steps involved in planning:

i) prioritise the problems
ii) set goals for each problem
iii) select appropriate interventions
iv) writing the care plan

You are now going to build a Care Plan for your medical patient Mr Connolly.


Patient's Name Andrew Connolly DOB 16/8/35 PAS 7536542
Date 21/10/91 Consultant D. Beattie Medical Diagnosis Ketoacidosis
Care Plan
Activity of Living
Care Plan
Maintaining a Safe Environment
PROBLEMS
Altered Level of Conciousness
Potential for Injury due to drowsiness
Choose a problem by selecting and snatching in the usual way.
The problem will then be visible on the Care Plan.
Now use the arrows to explore the goals associated the problem that you have entered on the Care Plan. If you were click over the hand it would return you to the Activity of Living section.
Use the CARE
This button
Use the


Patient's Name Andrew Connolly DOB 16/8/35 PAS 7536542
Date 21/10/91 Consultant D. Beattie Medical Diagnosis Ketoacidosis
Care Plan
Altered Level
Use the CARE
This button
Use the
Maintaining a Safe Environment
Care Plan
Altered Level of Conciousness
GOALS
Patient will be more aware
To identify promptly changes in the patient's level of conciousness
Select and snatch a goal in the usual way.
Use the CARE PLAN button to look at the Care Plan (you will be returned to this point if you press the CARE LIBRARY button on the Care Plan). Use the arrows to explore the interventions.

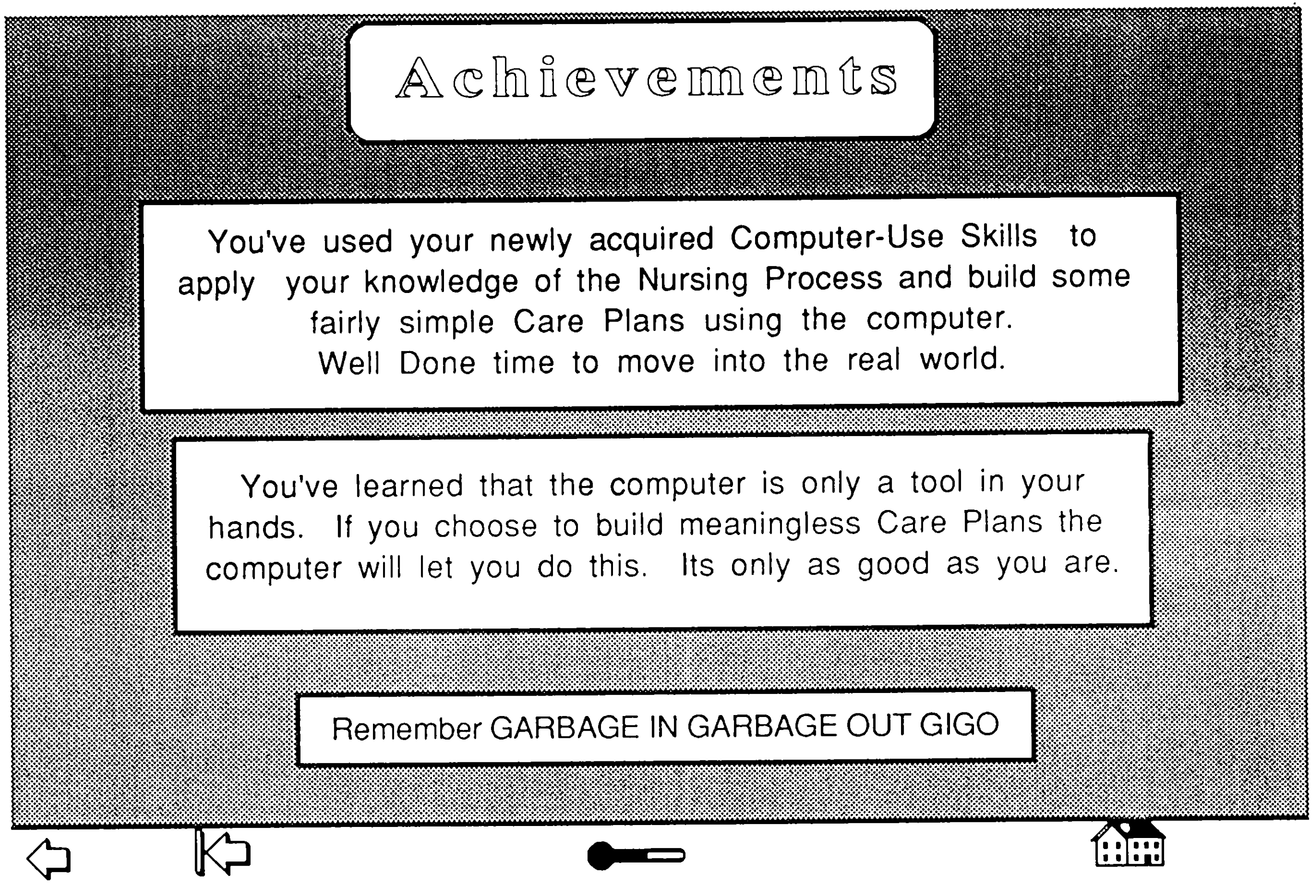

Patient's Name Andrew Connolly DOB 16/8/35 PAS 7536542
Date 21/10/91 Consultant D. Beattie Medical Diagnosis Ketoacidosis
Care Plan
Altered level of Conciousness
Care Plan
To identify promptly changes in the patient's level of conciousness
INTERVENTIONS
Monitor the patient's vital signs constantly
Assess and record the patient's level of conciousness and neurological status every 2 hours
Assess patient's blood pressure, pulse, and respirations hourly
As before enter appropriate interventions on to the care plan.
Use the CARE PLAN button to look at the Care Plan.
Click over the hand to retrace your steps to other problems
or back to the Activities of Living section.

Patient's Name Andrew Connolly **DOB** 16/8/35 **PAS** 7536542
Date 21/10/91 **Consultant** D. Beattie **Medical Diagnosis** Ketoacidosis

Care Plan **Delete** **Care Library** **Done** Review

Altered Level of Conciousness
To identify promptly changes in the patient's
level of conciousness 12 hours
Assess and record the patient's level of conciousness and
neurological status every 2 hours
Assess patient's blood pressure, pulse, and respirations hourly

Use the CARE LIBRARY button to take you into the information for building up the Care Plan.
This button will also return you to that section of Care Plan building that you came from.
Use the scroll bar at the side if your plan covers more than 1 page.
Use the DONE button once you have completed your Care Plan to your satsfaction.
The DELETE button will erase all the informationon your Care Plan so use this carefully.


Achievements
You've used your newly acquired Computer-Use Skills to apply your knowledge of the Nursing Process and build some fairly simple Care Plans using the computer.
Well Done time to move into the real world.
You've learned that the computer is only a tool in your hands. If you choose to build meaningless Care Plans the computer will let you do this. Its only as good as you are.
Remember GARBAGE IN GARBAGE OUT GIGO