Towards effective teaching strategies with interactive multimedia

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TOWARDS EFFECTIVE
TEACHING STRATEGIES
WITH INTERACTIVE
MULTIMEDIA

A thesis submitted in partial fulfilment of the
requirements for the award for the degree
Master of Education (Hons)
from
The University of Wollongong
by
Brian Ferry
Faculty of Education

1993
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Abstract

This study examined a process that introduced interactive multimedia technology to teachers. Teachers were the focus because they provide important links between learners and the interactive multimedia instructional materials.

Teachers are unlikely to adopt interactive multimedia, if they find it complex and foreign, and one aim of the study was to find ways to make this technology accessible to teachers and learners. The study also suggested ways to encourage teachers to employ learner-centred strategies that support instruction delivered by interactive multimedia.

The findings suggested that effective training of teachers in the use of interactive multimedia technology requires more than instruction in the use of the technology. It also requires that teachers re-examine their attitudes and beliefs about learning, and to base their teaching upon a new paradigms constructed from this process.

Instructional designers should consider the training of teachers as part of the total instructional package because well designed software and teacher support can make instruction with interactive multimedia more effective.

Teachers and schools must also be prepared to make a real commitment in terms of time and effort as this will enable them to learn new skills, and re-examine and modify practices so that they can take full advantage of this mode of instruction.
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CHAPTER 1: INTRODUCTION

Background

The introduction of technology in education has a history of broken promises and poor performance (Hedberg, 1989) and this history has affected the way that computers and associated technology have been accepted by teachers. Many teachers and administrators have become wary of visionaries bearing computer-based gifts (Sewell, 1990).

This lack of acceptance and adoption of technology in schools can be traced back to the way that each invention has been presented and marketed (Hedberg, 1989). Too often the invention was presented as a solution to many of the problems associated with education and each new design feature was touted as a time saving device that teachers and administrators needed. When the invention failed to live up to these promises and was not widely adopted, it was often abandoned and its inventors and supporters roundly criticised. A closer look at the invention may reveal that it did not fail but the criteria used to evaluate its success were too narrow or inappropriate. For example the time scale used may have been too short, or it may have been more appropriate to judge the invention by the attitudes and perseverance of those who used it as a tool than by the technology itself.

The introduction of computers into schools provides an example of how technology can promise much and produce little. Originally, the hardware and small amount of software available was used by a dedicated minority of specialists who had a great interest in programming and technology, but at the time this had little or no direct relevance to their teaching context.
This enthusiastic minority used a special patois and often developed into a significant power group within a school.

Other teachers who may have been interested in the technology, found it difficult to break into this power group because they were unable to receive system-based inservice training, or the few courses available from Technical (TAFE) colleges and universities could not meet enrolment demands. Also few "user friendly" applications could be applied to the context of their teaching. As a result, many teachers developed negative attitudes towards computers and the small group of users in their schools (Summers, 1990).

This situation is changing but there are still many teachers who have negative attitudes toward computer technology (Summers, 1990; Wiske, 1988; Baumgarte, 1984). However, through positive experiences with computers these attitudes can be changed (Summers, 1990).

Hedberg (1989) suggested a reason for this problem of lack of acceptance when he stated that too often the technology hardware is viewed in isolation from the context in which it is employed. If this is the case, then it is important to find out how to present new technology from a perspective that makes it relevant to the context in which it is used. This study examines the introduction of interactive multimedia technology into the teaching process. Teachers are at the focus of this study as they will provide the critical classroom link between students and the technology.

**Interactive multimedia**

Multimedia information may be in the form of text, sound, and images stored on magnetic or optical discs. This information is accessed through software on
a conventional computer hardware/software linked to a laser disc player, CD-ROM or other large storage device

Interactive multimedia evolved from convergence of audio-visual and computing technologies. In particular, the technologies of desktop publishing, hypertext and the optical storage, compact disc have been combined into a form of instructional technology (Barker and Tucker, 1990) variously labelled as "interactive video", "interactive television", "compact disc interactive", (Faulkner, 1991) or "interactive multimedia". For the purposes of this study interactive multimedia will include all of these.

The software design of Interactive Multimedia permits instructors and learners to interact with stored multimedia resources in many different ways which can be represented along a continuum. At one end of this continuum the instructors and learners can construct multimedia learning paths tailored to their specific needs; at the other end, they can follow a didactic control mode that uses a prescriptive learning path (Ross, 1991). In between these extremes learners and instructors can work together in a collaborative role.

Often the software allows learners to follow or create learning path(s) that suit(s) their unique learning requirements (Sewell, 1990), but to do this, the learner has to explore, and at times, reconstruct information and ideas presented in the stored multimedia. This process of interaction via appropriate software allows the learner and the computer to communicate with each other so that chosen goals can be achieved (Price, 1991), but without advisement, learners usually make ineffective choices (Jonassen, 1988). It follows that much depends upon the teacher's ability to prepare the learner and the learner's ability to make wise choices of goals.
The hardware associated with interactive multimedia typically consists of a computer and a laserdisc player tethered to a television screen as shown in figure 1.1. The computer and its software control the laserdisc drive. This drive uses 30cm laserdiscs (or videodiscs) which store multimedia information that may be in the form of text, sound, and images. However, this hardware is changing as shown by the recent integration of CD-ROM drives into computers. Such an integrated system is compact and presents the user with less hardware to manage.

FIGURE 1.1 AN EXAMPLE OF TYPICAL HARDWARE REQUIRED FOR INTERACTIVE MULTIMEDIA THAT USES VIDEODISCS

![Diagram of typical hardware required for interactive multimedia]

Computer and hard disk drive

Television monitor and laserdisc player

Relationships between other fields of educational research and interactive multimedia

A typical example of an interactive multimedia instructional package has one or more videodiscs. Each videodisc can store 54 000 frames that are equivalent to 678 carousel slide trays or one hour of video playing time on each side of the disc (Schaffer, 1985). Access to this material takes from 2 to 6 seconds
(Schaffer, 1985) and is controlled through a combination of conventional computer hardware/software and video disc technology. The great interest of the educational and training communities in this technology stems from the fact that the information stored on the videotdisc is independently addressable. Therefore, users can access information in any order they wish; breaking away from the sequential nature of other forms of multimedia.

Figure 1.2 represent the fields of educational research that have contributed to the development of instructional interactive multimedia. Information technology can be thought of as the application of theory and technology from the fields of computing and audio visual communication to produce electronic forms of information dissemination. The research field of instructional technology applies theory from information technology, educational psychology and curriculum amongst others to the educational use of electronic forms of information. This field is represented by the sections labelled with the letters IT. Educational interactive multimedia (IM) is the field where these overlap to produce a unique form of learning that makes use of what researchers believe is a basic human cognitive process, the associative link (Price, 1991). By associative links, the human brain can store and retrieve information quickly and intuitively. Interactive multimedia learning environments allow learners to use associative links.
The overlap between these research fields is changing as interactive multimedia technology develops and research in the field grows. With the passage of time, the integration of the technology associated with computers and audio visual communication will also cause these fields, represented by circles, to overlap by larger amounts as shown in Figure 1.3.
Interactive multimedia teaching strategies

It cannot be assumed that the development of the technology of multimedia alone will lead schools to adopt the technology. Given that teachers are unlikely to use the technology if they find it complex and foreign, then it becomes important that research is directed at finding out how to make this technology accessible to teachers.

Summers (1990) has shown that negative feelings of teachers about computer based technology associated with a lack of experience with computers, can be altered though recent positive experiences. Strategies about how to introduce computer based technology (such as interactive multimedia) are required so that teachers feel comfortable with the technology.
New innovations have been presented to teachers in many ways. Two typical approaches to training lie at opposite ends of a continuum. One approach employs consultants who have the required expertise to instruct teachers intensively, at regular intervals in the technology. The other employs the technology alone to carry out instruction. For a given teacher there may be an optimum or ideal choice along this continuum. Using consultants is likely to be expensive in terms of time and money. The approach has a limited benefit as technological changes inevitably require further retraining of teachers (Winslow, 1991). The "through the technology" approach is more expensive in terms of initial development cost but this instruction can "stand-alone" and minimises the time required to train teachers by outside experts. Therefore, the "instruction through the technology" approach should prove itself to be more flexible, cost efficient and effective, but how does this approach cater for teachers who prefer instruction by human experts? Can the "instruction through the technology" approach provide satisfactory experience for these people?

The use of an "instruction through the technology" approach also raises questions about what form this should take. Interactive multimedia packages can fail to be "user friendly" if the support included (software and printed manuals) is too complex, or poorly structured making it frustrating to use. A simplified form of support would be more appropriate for novices ensuring the experience will be a positive one.

Differing abilities and attitudes of teachers, make it necessary to provide instruction in a variety of forms and this study will examine the effect of two forms of support (an instructional booklet and a hypertext system) upon
teachers who are novice users of interactive multimedia. The research will provide an insight into the form of support teachers employ when they use interactive multimedia in the classroom.

An issue that is also of concern is the question of how much student-control of learning will be allowed by teachers. Hawkins and Sheingold (1987) showed that teachers favoured teacher-centred control of learning when they initially used computers with their classes and the shift toward pupil-centred control was very slow. This can create tension between students and teachers as much software is designed to allow the control of its use to shift toward the student. Teachers are likely to favour teacher-centred learning strategies when they first use interactive multimedia media and this could affect the success of the technology in the classroom. Research is needed to determine if there are ways of encouraging teachers to adopt more pupil-centred learning strategies.

A critical issue related to the problem of teacher-control is that of the teaching strategy adopted. Teachers have spent the majority of their working lives managing the instruction of large numbers of students. Often the most convenient and efficient method for the teacher is to manage the group as a unit. Thus a teaching model of mass instruction is employed. This is often based upon the provision of a common learning task to all students at the same time. This model works if the students have similar abilities and the learning task matches their abilities, and stages of development. The role of the teacher in a typical lesson that is based on this model, is to provide the instruction and the material required for the learning task, to monitor each learner's progress and to assist those who are having difficulties. To make this model even more efficient schools organise classes into year groups based
upon age and these year groups are subdivided into classes based on ability levels. The "ability levels" used (reading, spelling, language, mathematics) for division into classes related to the basic skills that are used in mass instruction lessons. The organisation of schools supports this teaching paradigm (Middleton, 1982) and perpetuates a process that promotes children through the system on the basis of how well they learn from this instructional model.

Interactive multimedia facilitates instructional strategies that allow for individual and group learning. It also encourages self-exploration and peer collaboration. Thus the teacher's role is no longer one of delivery and monitoring, but one of facilitation, small group organisation, collaboration, discussion and co-research. This requires teachers to broaden their teaching skills (Litchfield, 1990) and the skills of their students. It demands that teachers re-examine the strategies they use. Thus, it is likely that some form of retraining or inservice in pupil-centred teaching methodology is needed.

It is certain that the impact of interactive multimedia will be diminished if teachers employ teaching paradigms that are not supportive of the instruction delivered by the technology. This study has been designed to investigate this important issue and suggest recommendations for addressing this problem. In particular it will investigate factors that may encourage teachers to re-examine and modify the teaching strategies they employ with this technology.

Gagné (1984) claimed "the new technology of microcomputers, and the videodisc alone or in combination with the computer, offer great opportunity for studying human learning and the required conditions for effective human learning. These new systems virtually demand that we undertake new kinds
of research, that we ask questions within the context of the learning situations 
that these media make possible"; and this study is a contribution to the 
knowledge in the field of educational technology. Figure 1.4 (after Hawkridge, 
1981) shows an idiosyncratic map of the field of educational technology and 
indicates areas of knowledge that contribute to this growing field. The lines 
represent connections between these areas. This study is designed to 
contribute to the area of information processing (shaded grey) by providing 
further understanding of the learning environments required by teachers when 
they use interactive multimedia.

**Limitations of the study**

In this study, the number of post-graduate subjects available, and the need to 
balance undergraduate and post-graduate numbers limits the size of the 
sample. The non-random selection of subjects also limits the generalisations 
that can be made. Nevertheless, the results should provide a useful starting 
point and clarify directions for further research.
Changes since 1981

FIGURE 1.4 AN IDIOSYNCRATIC MAP OF THE FIELD OF EDUCATIONAL TECHNOLOGY (AFTER HAWKIDGE 1981)

Can now be converted into digital form and published on a computer platform.
Organisation of the thesis

Chapter 2 is a review of relevant literature related to the use of interactive multimedia in education. It identifies issues associated with the introduction of interactive multimedia in schools and with the training of teachers in the technology. The research questions that emerged from this literature review are the basis for the hypotheses constructed in Chapter 3, the methodology chapter. This chapter defines the variables, develops the hypotheses and describes the experimental methods used. Chapter 4 contains the results of the experiments and the statistical analysis of data. The result for each hypothesis is also discussed in this chapter. Chapter 5 concludes the study by synthesizing the results and making recommendations for further study.

The appendices contain the questionnaires used, the recording sheets for observations, the instructional support material used, and samples of the data.
CHAPTER 2  LITERATURE REVIEW

This literature review outlines the historical developments in educational technology that led to the emergence of interactive multimedia as an instructional technology. It reviews the early theory associated with audio-visual and computer-based instruction and then focuses on technological aspects of interactive multimedia. Developments associated with educational software and instructional design theory that relate to interactive multimedia are discussed along with issues raised by research in this field. Instructional applications of interactive multimedia are reported and issues relating to the training of teachers in the technology and the adoption of this technology in schools are identified.

The chapter concludes by posing research questions that may assist researchers to understand how the training of teachers in the use of interactive multimedia can be improved. These research questions will then be investigated during the course of this study.
<table>
<thead>
<tr>
<th>Form of Instructional Technology</th>
<th>Knowledge organisation</th>
<th>delivery options</th>
<th>model of the learner</th>
<th>learner control and interaction</th>
<th>hardware required</th>
</tr>
</thead>
<tbody>
<tr>
<td>1950's audio tape recording</td>
<td>expository, sequential presentation</td>
<td>sequential information, drama</td>
<td>receptive audience</td>
<td>on, off, fast forward, rewind, stop</td>
<td>general purpose</td>
</tr>
<tr>
<td>1950's programmed learning</td>
<td>expository, guided learning</td>
<td>drill</td>
<td>a receiver of knowledge provided by the program.</td>
<td>can control rate at which frames are presented</td>
<td>booklets and teaching machines.</td>
</tr>
<tr>
<td>1960's computer-assisted learning</td>
<td>expository, guided learning with some self discovery</td>
<td>drill and practice, games, simulation</td>
<td>follower of a predetermined path with some branching paths</td>
<td>rate at which information is presented, some options plus limited control over the sequence of presentation</td>
<td>computer plus appropriate, software often poorly designed</td>
</tr>
<tr>
<td>1960's television.</td>
<td>expository, sequential presentation</td>
<td>sequential information, drama</td>
<td>receptive audience</td>
<td>on, off, programs offered</td>
<td>general purpose</td>
</tr>
<tr>
<td>1970's video cassette</td>
<td>expository, sequential presentation</td>
<td>sequential information, drama</td>
<td>receptive audience</td>
<td>on, off, fast forward, rewind, stop freeze frame, frame searches</td>
<td>general purpose</td>
</tr>
<tr>
<td>late 1970's videot disc</td>
<td>interactive presentation. Students can make their own learning paths.</td>
<td>random or sequential information, drama</td>
<td>receptive audience or interactive learners(s)</td>
<td>random access to information stored</td>
<td>general purpose hardware plus videot disc player</td>
</tr>
<tr>
<td>1970's intelligent computer-aided instruction</td>
<td>mainly guided self discovery</td>
<td>tutorial (inquiry), games</td>
<td>co-learner able to collaborate with the system to learn.</td>
<td>entry level, rate and sequence of presentation, able to seek help and ask questions.</td>
<td>computer plus appropriate software</td>
</tr>
<tr>
<td>1980's interactive multimedia</td>
<td>guided or self discovery along many different learning paths</td>
<td>random or sequential information, drama which may or may not follow predetermined learning paths.</td>
<td>receptive audience or interactive learner(s) that collaborate with the system</td>
<td>rapid random access to the information stored available at all times</td>
<td>general purpose hardware plus videot disc player plus computer and software</td>
</tr>
<tr>
<td>1980's satellite television</td>
<td>expository, sequential presentation</td>
<td>sequential information, drama</td>
<td>receptive audience</td>
<td>on, off large variety of programs offered</td>
<td>general purpose plus antenna</td>
</tr>
</tbody>
</table>
Historical perspective

Table 2.1 on page 15 summarises major developments in audio-visual and computer technology from the late 1950's to 1990. The term "general purpose hardware" refers to hardware that can be bought through commercial outlets such as department stores.

In the 1950's early forms of educational technologies were expository and sequential, and based upon a model that assumed students were a passive, receptive, audience. This placed the control of the presentation and the subject matter in the hands of the teacher or instructional designer who could expand or limit delivery options. The emphasis in the research effort was in the design of the message to be communicated.

By the 1960's computers became available to some educational institutions and this technology expanded learning options, but the educational software available allowed limited learner control. Educational use of television also began to have an impact in the 1960's, but the presentations were sequential and predominantly based upon a didactic model.

The development of videodisc technology in the late 1970's allowed video to be stored on discs. The information stored could be retrieved rapidly and in any order. Therefore, teachers could give learners greater control of their learning through this technology.

By the late 1970's students and teachers began to access video recorders and commercial video tapes. They could record relevant television programs or hire commercial programs, and the classroom teacher could play the video
recording for the class to view and discuss; but the presentation of the video was still teacher-controlled and sequential. However, the penetration of the hardware was very limited.

By the 1980's computer hardware and software systems were developed to link with multimedia stored on videodisc. This improvement of the hardware and the software has given instructional designers increased opportunities to develop instructional systems that allow greater student control of the learning options offered.

Computer-assisted instruction also evolved toward a system that placed greater emphasis on internal learner control rather than externally imposed control. Because learners were able to make more decisions about how they used the instructional program than in the past, there was more interaction within and between groups of learners. Software design shifted from a predetermined system of learning where learners were provided with limited options to systems that allowed a choice of learning options.

 Teachers could take advantage of this improved educational technology by organising students into cooperative groups, collaborative pairs or individuals. These ways of organising students were different from traditional methods and required teachers to develop organisational strategies that fostered social and organisational skills that supported cooperation and collaboration rather than individual competition.

Television technology evolved from regional broadcasts to national and international broadcasts via satellite. By the 1990's television broadcasting was
linked to other communication technology to produce more advanced forms of communication. Currently researchers are developing telecommunication links with computers and multimedia databases to create a form of distance education that will allow multiple users to have a high degree of interaction. Systems are planned to allow students to communicate to a centralised database via satellite or fibre-optic cable. The database can provide lessons, and research material in the form of text, sound or images, and the same communication system can also provide electronic mail and telecommunication links to other students and the lecturer (Barker and Tucker, 1990). Students can use their computer and telecommunications link to ask questions, communicate with each other and the lecturer, as well as submit and receive assignments. Under this system the "traditional" teacher is not involved in the delivery of instruction, instead instructional designers, who may be teachers, are involved in the design of learning materials which students access. Some may also be involved in on-line tuition and assessment of assignments submitted electronically.

The general trends in educational technology over the past forty years have been to: increase computer control of the technology; develop more sophisticated hardware and software; link stored media to software via a computer platform; and develop more sophisticated communication links. This has led to the production of learner-centred instructional products that permit a variety of learning options in a variety of locations, and challenges teachers to reconceptualise instructional strategies.
Instructional technology

Theoretical antecedents of early 1960's instructional technology came from two sources:

- audio-visual materials designed to service the requirements of instructors and the education system. While communication theory was applied to the design and use of these resources, little theory was applied to how learning occurred through this technology (Eraut, 1989). The most frequently used conceptual model was Dale's cone of experience (in Eraut, 1989) which placed "direct purposeful experience" at the base and "verbal experience" at the apex.

**FIGURE 2.1 DALE'S CONE OF EXPERIENCE (1969)**

- increased sensory participation
- Direct purposeful experiences
- Contrived experiences
- Dramatized experiences
- Demonstrations
- Study trips
- Exhibits
- Educational television
- Recordings radio, still pictures
- Motion pictures
- Recordings
- Visual symbols
- Verbal symbols
Audio-visual presentations were positioned just below the apex and were considered to provide greater sensory experience than verbal experience but they did not provide as much sensory stimulation as the experiences located at the base of the cone.

Most presentations were delivered to learners organised into mass audiences but this arrangement led to little interaction because the instructor presented all learners in the audience with the same material at the same rate. At best, instructors could stop the presentation at critical points and discuss important issues.

• programmed learning based upon the work of researchers such as Skinner (1958, 1968). This was driven by learning theory closely associated with programmed learning theory (Lumsdaine, 1964).

Instructional designers applied this theory to the design of instructional software. The focus of this approach was the learning task and instructional designers concentrated upon breaking down learning tasks into smaller sub-tasks that could be arranged into a logical sequence of steps. Each step could be drilled, tested, and feedback loops provided for learners who were having difficulties. It was reasoned that if the steps were simple and logical then learning would occur.

The software design focussed on drill and practice using highly structured, individualised, self-paced exercises that provided immediate reinforcement after each step. Learners were treated as individuals and were presented with a carefully prepared learning task which they completed at their own rate. The
learning program or teaching machine controlled the learning path and provided feedback, but there was little interaction between learners, and between learners and instructors, because it was assumed that the instructional program would provide the motivation and the assistance.

This approach created problems for learners who found the steps in the program too easy or too difficult. One group became bored with the lack of challenge, while the other group lost interest because it was too difficult.

*Beliefs about audio-visual instruction*

Eraut (1989) states that in the past commonly held beliefs about audio-visual resources were:

1. stimulus richness and variety enhances attention and motivation. Therefore a presentation that employs a variety of stimulating sounds and images should motivate learners and be effective.

2. the more use, the better the outcomes. Therefore frequent use of audio-visual presentations leads to better learning outcomes.

3. a degree of abstraction was needed. Audio-visual presentation were enhanced when they included visual and verbal symbols.

But, researchers such as Bruner (1966) and Travers (1970) subsequently showed that these past beliefs did not hold. In particular they showed that:
• there are limits to the amounts of information that can be received and processed at any one time. Therefore, the inclusion of large amounts of stimulating audio-visual material is counter productive.

• what is seen and heard is structured by pre-existing cognitive/perceptual schema. Therefore frequent use of audio-visual presentations is unsuitable for many learners.

Piaget's (1971) work on stages of mental development and the acquisition of knowledge did not support the belief that the frequent use of audio-visual materials that used a degree of abstraction were likely to produce better learning outcomes. In particular, the key processes of assimilation and accommodation take time and are repeated during each successive stage of development which involve learners in exploration of concrete materials. Such processes involve the learner in filtering and modifying input from the environment to fit his own internal schema; therefore an audio-visual presentation to a mass audience is likely to have a limited effect.

Computer-assisted instruction

By the late 1960's access to computers had increased, and as a result, research about computer-assisted instruction (CAI) also began to increase. CAI is instruction delivered primarily by computer (Hannafin and Peck, 1988), and for this study, the definition includes all the acronyms listed below: CAL computer-assisted learning, CAI - computer-aided instruction and CBI - computer based instruction.
Many instructional programs were no more than a transfer of the model of programmed learning to a computer program that acted as an electronic page turner, while the student acted as a passive receiver of printed information (Hannafin and Peck, 1988). Programs concentrated on drill type activities that were often boring and lacked strategies to motivate most students. However, well designed drill and practice programs had some advantages (Sewell, 1990), and these were:

- menu driven software that was easy to follow for students and teachers.

- basic skills can be improved through repeated practice because skills become "automatic" with repeated rehearsal. Gagné (1982) emphasised the importance of automacity in assisting learners to develop low level skills needed in the performance of more complex activities. Examples might be drawn from some simple spelling, reading and mathematics programs.

- individualisation allows learners to proceed at their own rate.

- immediate reinforcement. The software immediately informs the learner about the accuracy of performance and remediation loops could correct misunderstandings.

- extrinsic rewards, such as finishing in the shortest time with the least mistakes, motivated some students.

Computers had the power to do a great deal more, but at the time, the computer hardware limited the ways that instructional design theory could be
applied to the software. For example many programs were limited by the amount of free memory available and the design of the human-computer interface.

Increased research into computer assisted learning emphasised the need for greater understanding of the interaction between the learner and the computer. This placed greater importance on the concept of interaction as a theoretical issue in instructional design. In 1965 Lewis and Pask mentioned this issue when they discussed "the possibility of creating as well as satisfying goals", and by 1969, Moore expanded this idea when he discussed "autotelic activities" that permitted the learner to:

- explore freely.

- immediately find out the consequences of his/her actions.

- be self pacing.

- make full use of his/her capacity for discovery.

- make a series of interconnected discoveries about the physical, cultural, or social world.

A response to concerns with drill and practice software during the mid 1970's (Sewell, 1990), was further research into intelligent tutoring systems. The focus of these systems included the learner and the task. No longer was it assumed that following a planned sequence of simple steps would lead to effective learning. Elementary forms of these systems used software to create a learning
path that responded to the learner's keyboard input. This input was used to monitor the learner's progress, and to provide the most appropriate learning path. The challenge for instructional designers was, and still is, to design a program that can accurately form a model of the learner so that the most efficient and effective learning path can be followed at all times. Therefore, instructional designers have to re-evaluate the instructional design theory they apply (Carrier, 1984; Hannafin, 1986b). In 1991 Bork synthesized these ideas when he stated that "new developments involving technology in education should be student-centred, rather than administrative-centred or teacher-centred," but there is a danger that the role of the teacher in this learning process will be ignored.

The development of technology that delivers interactive multimedia

Video

The development of video cassettes in the 1970's made video a popular way of presenting audio visual material to students. The reasons for the popularity of the technology were (Schaffer, 1985):

- the ease of use.

- cost.

- availability of source material.

- readily changed content.
• in-house production possible.

• rewind and pause functions allowed the presentation to be interrupted and repeated (although many researchers found these functions were not employed).

A great deal of learner interaction was possible when a teacher was skilled in the use of video presentations. For example, a teacher could repeat a segment of a video to clarify misunderstandings or to emphasise an issue which could be discussed by the students.

After extensive use, it became clear that there were limitations with videotape presentation and these were:

• the sequential nature of the presentation. Fast forward and rewind facilities were present but only expensive machines employed the more useful frame searches which took a long time.

• freeze frames were of poor quality and of limited duration. The picture was blurred and the pause button could only be held for a short time.

• picture quality deteriorated with use. Therefore frequently used tapes had to be re-recorded.

Video is in regular use in schools and children may share in the ownership of the presentation when they bring their video cassettes to school. Similarly teachers may record material for classroom presentation. High quality
commercial programs exist but the limitations of the presentation mentioned previously, plus cost, and the limited currency of many topics, discourages extensive purchases.

As pre-service and inservice teachers receive little advice about appropriate ways to use video with their classes, it is not surprising that they often use teacher-controlled presentations based upon teacher-selected video material. For similar reasons students access to a school video camera may be limited.

Computers have been interfaced with video cassette players but for the reasons mentioned previously, the programs have had limited success.

**Videodiscs**

The idea of videodisc technology had been anticipated in the 1920's when, in 1927, John L. Baird engraved video signals on to a gramaphone disc (Eraut, 1989). During the 1970's four different approaches to the development of the modern videodisc were tried (e.g. laser optical reflective by Philips-Netherlands, laser optical transmissive by Thomson-CSF-France, capacitive (grooved) by RCA-United States, capacitive (grooveless) known as the VDH (video high density system) by JVC-Japan). The VDH system has made some penetration into the consumer marketplace in Japan, but reflective laser technology as developed by Philips (Netherlands) became the most popular standard (Schipma, 1989) because the technology could be applied to the consumer market in the form of digital audio or compact discs (CD) developed by Sony and Philips in 1982. CD's became the fastest growing consumer product ever known. The success of this application of technology
has spawned additional applications such as CD-ROM (compact disc/read only memory, 1985), CD-I (compact disc interactive, 1986) and DV-I (digital video interactive, 1988).

CD-ROM uses the same technology as compact discs to store data for use by a computer, and one disc currently holds 550 million characters of information compared to 360 thousand characters for a typical computer floppy magnetic disc. CD-I discs store audio, computer data and images in digital form and is produced by technology that is similar to that employed for compact disc production. DV-I is similar to CD-I except that the data stored is in the form of video. All of these forms of information and videodiscs (laser disc) have high quality audio and video with excellent stillframes and almost no deterioration with use.

In 1978 the Magnavox optical videodisc player was the first to appear on the commercial market. It was quickly followed by other models which evolved from panel control, to remote control, to control by a companion computer. With each change in control came new ways of using the technology. For example, computer control allowed rapid random access to data stored on the disc and the possibility of learner interaction with computer software and stored resources.

Clark (1984) compared the strengths and weaknesses of interactive video (stored on tape or disc) with other methods of delivery as shown in table 2.2. The table has been modified in the final row to include today's technology
While the table can be criticised for being too general, comparisons between film, slides, videotape and videodisc are useful, provided it is recognised that the amount of learner control is also a function of the ability of the learner to correctly use the technology. A skilful instructor can allow a certain amount of learner control of the direction and pace of a lecture by techniques such as questioning and the reading of the body language of students. Information from books can be rapidly accessed in the hands of skilled users. Also conversation between learner and instructor, and learner and learner is not always controlled by the learner because the learner may not have the power or the skill to initiate, direct or end the conversation.

**TABLE 2.2 A COMPARISON OF EDUCATIONAL DELIVERY SYSTEMS**  
(AFTER CLARK, 1984)

<table>
<thead>
<tr>
<th></th>
<th>Rapid Random Access</th>
<th>Computer Control</th>
<th>Branching</th>
<th>Learner Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lecture</td>
<td>No</td>
<td>No</td>
<td>Possible</td>
<td>Low</td>
</tr>
<tr>
<td>Film</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Low</td>
</tr>
<tr>
<td>Slide Tape</td>
<td>No</td>
<td>Possible</td>
<td>Possible</td>
<td>Low</td>
</tr>
<tr>
<td>Videotape</td>
<td>Slow</td>
<td>Yes but slow</td>
<td>Yes but slow</td>
<td>Low</td>
</tr>
<tr>
<td>Textbook</td>
<td>Slow</td>
<td>No</td>
<td>Yes but pre-determined</td>
<td>high</td>
</tr>
<tr>
<td>Conversation</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>high</td>
</tr>
<tr>
<td>Video disc, CD-ROM, CD-I, DV-I</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>high</td>
</tr>
</tbody>
</table>
As shown in the table, the features of rapid random access, computer control, branching and learner control rated highly, and make the videodisc, CD-ROM, CD-I and DV-I very adaptable compared to alternatives such as video tape.

Authors such as Bennion and Schneider (1975) anticipated many educational applications that were to result from the rapid developments in audio-visual technology such as compact-discs. While such devices allowed rapid random access to material stored on a disk, only more expensive systems allow users to re-record. This limitation would be of concern to teachers who prefer to customise instructional materials, but it could be overcome by choosing generic subject matter and developing interactive multimedia programs designed to allow teachers to arrange the order of presentation of learning sequences to match their educational objectives.

Recent developments

Multimedia hardware and software can be integrated to produce a stand-alone system such as compact-disc television (CDTV) introduced in 1991 by Commodore computers. It was the first integrated system designed for the general consumer market and used a special compact-disc player with built in computer interface connected to a normal television receiver. A remote hand held key pad allowed users to access the material stored on the compact-disc via the television receiver. By 1992 other companies such as Philips and Sony released a similar product called compact disc interactive (CD-I) but the development of affordable CD-ROM drives that connect to computers meant
that it was cheaper for consumers to add a CD-ROM drive to their present computer. By late 1992, some major computer manufacturers started to build CD-ROM drives into the computers.

Many new interactive multimedia titles based upon adventure games and well known stories have been developed to make use of this platform. While compact discs currently store much less data than videodiscs, video compression and other techniques are expected to extend the storage capacity on each side to 75 minutes of video (which is greater than the current capacity of laser videodiscs).

In the United States, there are over 7,500 videodisc players in schools (Weiland, 1990) and the number of educational videodiscs titles has grown from 100 in 1986 to 600 in 1989 (Pollack, 1989). Some states of Texas and Florida, have declared videodiscs a teaching resource (Brock, 1989) and have committed state funds to the purchase of these resources, but the current evidence has not sufficient to sway most administrators to invest large amounts of capital.

The adoption of videodisc technology may only be a short-term decision as the cost of technology associated with audio compact discs (CD) has dropped dramatically with the market penetration of CD's (Schipma, 1989). CD drives only require a few chips to be changed to read CD-ROM and CD-I discs. General public and business use will further reduce prices (Faulkner, 1991) and this will probably encourage the use of this technology in preference to videodiscs.
While these recent improvements in technology have reduced hardware costs, labour-intensive software production is still expensive. "Generic discs" (Jonassen, 1984; Pollack, 1989) or "video databanks" (Cohen, 1984) containing information and software tools that allow the same material to be used for different educational purposes have been suggested as a solution, because economies of scale could be used to offset production costs.

Computer technology

Before 1975 few schools had access to computers because of their cost, size and specialised maintenance. Those schools fortunate in gaining some access were often involved with a research program associated with a nearby higher education institution that could allow access to a mainframe computer on a time-sharing basis. These computers were used for school administration, some elementary programming exercises and for the development and trial of programmed learning applications.

Changes in technology such as the development of "Altair" world's first microcomputer in 1975 and the Apple I computer by Jobs and Wozniak in 1976 lowered the cost of computers and made them more accessible to individual schools. They were also more reliable and easier to maintain than larger computers. However, they did require a certain amount of instruction for effectively use and they were not easy for novices to master. It was soon realised that computers and the software had to become easier to use and the term "user friendly" was coined in popular literature to describe computers and software that catered for all levels of user ability.
The more meaningful term "human computer interaction" describes the ways humans and computers interact. This interaction takes place at an interface through which the user gains access to input, display, control and storage systems. It is this interface that is often the most important factor in determining the success or failure of a computer system (Baecker and Buxton, 1987). Three common features of poor human computer interface design described by Galitz, (1989) were:

- the user language. Many words were strange and used in different contexts.
- inconsistency. Different actions could achieve the same result.
- unforgiving. There was no facility for undoing errors in commands.

The problem was to find out how to design the human computer interface in a way that was easy to learn, and easy and enjoyable to use (Norman, 1986).

One popular solution was the development of the graphic user interface (G.U.I.) and intensive research into graphic user interfaces led to the development of the Apple Macintosh computer in 1983. The graphic user interface developed for the Macintosh employed Windows, Icons, a Mouse and Pull down menus (W.I.M.P.) for human computer interaction. It wasn't long before other manufacturers were employing similar software systems (e.g. "Windows") that were also based upon a graphic user interface. These interfaces made it easy for users to link, the computer, to a laser disc or CD-ROM storage systems. Users could then have almost instant random access to this data but the challenge was, and still is, to design the delivery system so that learners can fully exploit the educational potential of the system.
Educational software development

Until the mid 1980's educational software was generally of poor quality and didn't use the potential of the computer (Hannafin and Peck, 1988). Originally there was a tendency to concentrate on drill and practice and tutorial modes as they were easy to apply and were a natural progression from programmed learning materials of the 1950's and teaching machines of the 1960's.

Even though other modes of educational software such as simulation, modelling, interactive knowledge based systems and information seeking systems became available (Rushby, 1989), their adoption was slow because of considerable effort and cost involved in development. This situation began to change as the number of educational consumers increased. They became more sophisticated and began to demand more of the software. Instructional designers responded to these demands by producing more interactive modes of software that gave greater control to learners.

Figure 2.2 (after Rushby, 1989) shows that these modes of educational software evolved from drill and practice with little user control, through to information seeking software that allowed greater user control.
FIGURE 2.2 CHANGES IN THE MODES OF EDUCATIONAL SOFTWARE
1950'S TO THE 1990'S

External

Locus of control

Internal

Drill and Practice

Tutorial

Simulation

Modelling

Interactive knowledge-based systems

Information seeking

1950's

1990's
Drill and practice has been defined previously.

Tutorial software attempts to construct a teaching dialogue with the learner and is modelled from the behaviour of expert teachers. It suffers from lack of flexibility because the computer can only follow pre-specified rules programmed into the software (Rushby, 1989).

Simulation attempts to provide learners with a study of real-life systems or phenomena. This form of software is useful when the learning experiences would be too expensive, too time consuming, too difficult, or too dangerous to study first-hand. The software programs the computer to emulate a real-life system and allows the learner to find answers to the question "what happens if...?" The main difficulty associated with simulations has been associated with the transfer learning to real-life (Rushby, 1989).

Modelling allows the learner to "teach" the computer rules, so that it can emulate a real-life system for a given set of circumstances and then predict the behaviour of this system in a new situation. The student must be provided with some means of teaching or programming the computer. This programming language needs to be in a simplified form, otherwise considerable time can be "wasted" in mastering the programming language (Rushby, 1989).

Interactive knowledge-based systems involve two alternate approaches. One approach provides a descriptive model of the knowledge relating to a particular topic, system or situation. The learner can explore this system and receive tutorial guidance and explanation from the software system, or by means of questions, come to understand and assimilate the knowledge. In the
alternative, the software allows the learner to build his/her own knowledge base and to "teach" the computer about the topic. Information seeking software allows the learner to use the computer as a mentor and guide through a range of learning resources which might, but need not, be themselves based on a computer. The power of the computer to store, retrieve, and process information is used to help the learner. At present this is the least developed mode of computer assisted learning.

The evolution these modes of computer-assisted learning was not a gradual linear sequence, but was one in which there were periods of rapid development stimulated by improvements in computer hardware and software. In general instructional designers have taken advantage of new developments to give greater control to the learner.

Such rapid changes in software and hardware have changed the way that learners and computers interact, and many teachers are uncertain about how to use these different modes of software with their classes. Instead there has been a tendency to "teacher proof" instructional software and provide a teacher booklet that contains lesson plans and black line masters of test material which may be self-correcting (Baker, 1989). If the teachers' role is reduced to providing the software and to organising students, there is a danger that the important human tutor role of the teacher will be ignored.

Because modern instructional software allows greater learner control and many different ways of employing the material, teachers find that the traditional methods of classroom organisation are not always applicable. Many uses of the technology can free teachers from continual management of large groups of students to concentrate on small groups or individual learners.
Teachers can adopt strategies such as small-group learning that give students considerable control over their learning. Hawkins and Sheingold (1987) suggested that teachers need to respond to these issues by acting as a facilitator of knowledge acquisition rather than as a provider of content specific knowledge. As a result, this would mean a significant refocussing of teachers work.

Hawkins and Sheingold (1987) also found that teachers tend to employ strategies that allowed them to control the learning when they begin to use new technology such as computers, but gradually, they allowed more pupil-centred control as their confidence grew. This study will follow up these findings and explore ways of assisting teachers to become confident with the technology.

*Computer assisted learning and intelligent computer assisted learning*

During the mid 1970's it became difficult to make sense of the vast amount of research occurring in this field. The technique of meta-analysis (Glass, 1976) made it possible for researchers to examine, and quantitatively synthesize the results of many studies. The advantages of this technique (Fitz-Gibbon, 1985) are:

- many small scale experiments can be included.

- small scale research conducted by lecturers and students become valuable as the results can be drawn upon and time does not have to be spent coordinating the studies.
Critics of this method such as Tripp (1985) argue that much depends upon the quality of the results to be synthesized and there is a danger in multiplying the inadequacies of the data base. But, researchers who used meta-analysis for past research showed that they were aware of these problems. For example meta-analysis of college based teaching by Kulik, Kulik and Cohen (1980) involved 59 studies from a pool of 500 titles. They rejected 441 studies for the reasons mentioned by Tripp and others.

The analysis of Kulik, Kulik and Cohen (1980) showed small improvements in achievement and attitudes, but there was substantial reduction in the time needed for instruction. This reduction in time may have been at the expense of interaction as recent studies by Shaffer and Hannafin in 1986 showed that the time need for instruction could be substantially cut if the amount of interaction was limited.

In 1983 Clark expressed concerned about the conflicting evidence about the advantages of computer assisted instruction (CAI) over other instructional media and found evidence of consistent confounding in the research. In comparison studies, which make up many studies, the most powerful factor seldom controlled was the greater effort in the design and presentation of the CAI presentation compared to its competitor. Researchers who used comparison studies needed to take into account these findings.

Clark showed that when researchers employed the same methods and content in all media compared, there was no significant difference. He claimed that the learning gains came from the application of adequate instructional design theory and practice, and not from the medium used to deliver the
instruction. Roblyer, Costine & King (1988) supported Clark's findings when their results showed that the effects of CAI systems were not significant except for minor gains in mathematics and science.

Results from such findings led some researchers (Megarry, 1988) to claim that intelligent computer assisted learning (ICAI) may have been a false path. Intelligent computer assisted instruction process was criticised because it tried to create a model of the student based upon evidence from the occasional key-press. The model, was lacking in data, but was still used by the computer to make decisions about what the student needed to learn from the system. Research by Gaines (1987) into intelligent computer assisted instructional systems applied to industrial processes supported this criticism by demonstrating that control theory was often inadequate because the system could not be accurately modelled.

However, there were some successful applications of intelligent computer assisted instruction and in 1988 Woolf showed that a specific and clearly defined intelligent computer assisted instructional system designed to train boiler operators could be successful. The reason for the success of this program (and others like it) was due to the provision of sufficient data to model the specific circumstances of boiler operation and a very specific set of human performance objectives; such as maintaining steam pressure within specified limits through the operation of a number of valves. Therefore intelligent computer assisted instruction can be effective when all the instructional objectives are accurately defined and the system monitors and reacts to the learner's input.
Limitations of intelligent computer assisted instructional systems were expressed by Self (1988) who claimed "no existing machine learning techniques seem adequate to maintain dynamic student models". He suggested that machine learning and student modelling may be well served by a collaborative relationship rather than a tutorial one. Therefore, it is prudent to use the computer system to model the knowledge base and to give the learner the freedom to interact with it; giving autonomy back to the learner (Hartley, 1981; Hedberg and Perry, 1985). Hedberg (1985, 1986) suggested that new theories of learning need to be incorporated by instructional designers to encourage greater student involvement with the learning process. Rather than give the learner an itinerary of pre-packaged learning resources that are structured, selected and assembled for them, we should consider giving them a map of the terrain and a survival kit. This an option that can be delivered through interactive multimedia as well as intelligent computer assisted instructional systems (Self, 1988).

**Interactive video**

Initially interactive video serviced adult training because the tasks could be clearly defined and the market was accessible and potentially profitable (Priestman, 1984). Meyer (1984) showed that in many technical applications, interactive video could provide sophisticated simulation training that was cost-effective compared to hands-on training. On the strength of research such as this, the US military installed many multimedia systems and currently 60% of the interactive multimedia programs sold are for the training market.

Research in the training of communications operators by Young and Tosi (1980) found that "a statistical comparison of learners using video
simulator equipment showed no difference in the actual ability to operate complicated communications equipment. Ferrier (1982) also found interactive video (or multimedia) to be cost effective for training applications associated with leadership, management, and organisational development. These findings indicated that interactive multimedia could be successful in delivering instruction to adults in specific training situations (such as industrial, military and medical training) but it did not indicate that it was successful in schools.

Despite the assertions of authors such as Kearsley and Frost (1985), there still remains a need for empirical research to demonstrate clearly the efficacy of using interactive video in education as opposed to training (Hannafin, 1985). Bosco (1986) presented a comprehensive and recent study of empirical evaluations of interactive video applications for instruction but only 8 of the 28 reports analysed were about school use. The meta-analysis by Bosco didn't establish that interactive video was consistently superior to comparative traditional methods, but a limited amount of data was available. However, recent research by Cushall, Harvey and Brovey (1989) showed that student attitudes, participation, enjoyment and learning all increase when they use interactive video.

Other studies also reported on the positive effects of learning with interactive video. For example, in 1984 Doulton indicated that improved standards of laboratory work occurred when interactive video was integrated with traditional teaching, and there was also the added bonus of saving time by not having to set up as many experiments. Teh and Perry (1984), Hannafin (1986) and Copeland (1987) also reported gains in learning because of student experience with this technology.
However, quantitative studies that use simple comparison are open to criticism for being too narrow because they are frequently based upon the accumulation of data associated with one or two hours weekly experience (Levine, 1990). The effects of these weekly experiences are compared with the learning gains of a control group(s). When new technology is adopted, there is a need to examine as many interactions as possible rather than a narrow set of pre-determined observations.

Qualitative paradigms have the potential to provide valuable information for instructional designers and planners as shown by case studies by Bayard-White (1986) that provided insight into creative applications of interactive video. Detailed analysis of the training needs of the organisations concerned were undertaken before proceeding with an interactive video "solution".

Hypertext software

Hypertext was anticipated by Bush (1945) and by Engelbart (1963). The term "Hypertext" was defined by Nelson (1967) as "a combination of natural language text with the computer's capacity for interactive branching, or dynamic display ...of a nonlinear text... which cannot be printed conveniently on a conventional page." Hypertext software allows users to explore knowledge in a non-linear and interactive fashion (Barker and Tucker, 1990). It became a reality in the 1980's when the computer technology and software development had reached the sophistication required. The development of Hypertext platforms such as Guide for Apple and IBM in 1986, Apple HyperCard™ in 1987, and LinkWay™ for IBM computers in 1989, created the possibility of developing a new and very different learning environment.
Researchers claim that Hypertext is a unique form of learning that makes use of what they believe is a basic human cognitive process; the associative link (Price, 1991). By associative links, the human brain can store and retrieve information quickly and intuitively. Users of Hypertext software can pursue a variety of suggested paths through media that may be in the form of: sound, text and images. They can create new pathways for themselves and for others to follow by forging new links and recording new combinations of the media. They can create personal knowledge structures and learning paths. The system controls who inserts links and whom (if anyone) amends and deletes sections. In table 2.3 Weyer (1988) identifies options available through Hypertext that are of value to the learner:

TABLE 2.3 OPTIONS AVAILABLE TO USERS OF HYPERTEXT SOFTWARE

<table>
<thead>
<tr>
<th>Request</th>
<th>System Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Guide me</td>
<td>suggest pathways but let me browse</td>
</tr>
<tr>
<td>Amuse me</td>
<td>find interesting connections or perspectives</td>
</tr>
<tr>
<td>Tell me</td>
<td>give the facts only</td>
</tr>
<tr>
<td>Teach me</td>
<td>provide step by step guidance</td>
</tr>
<tr>
<td>Inform me</td>
<td>give me the facts plus background and other viewpoints</td>
</tr>
<tr>
<td>Challenge me</td>
<td>make me find or create creative connections</td>
</tr>
</tbody>
</table>

The "guide me" request assists learners by suggesting pathways designed to achieve specific objectives, or it can let learners browse through the media without any guidance. Such a system requires navigation aids to avoid learners becoming lost. The "amuse me" request helps learners to find
interesting connections between ideas. Besides motivating learners these connections assist recall and aid understanding. The "tell me" request is a summary facility that provides basic information only. Learners can use this to develop their own summary. The "teach me" request is essential for novice users. It helps them to get started to successfully explore the system. The "inform me" request supports research skills because learners can use this facility to find out more information and develop new understandings. Through the "challenge me" request the learner can be challenged to participate in an adventure game, a simulation, research activities, or the development of a multimedia presentation. These activities can stimulate the learner to extend his/her knowledge and skills to meet the challenge presented.

When hypertext software is linked to multimedia the learning environment is called hypermedia. Hypermedia learning environments are controlled by hypertext software and have the same options available as hypertext. Table 2.4 compares the two types of hypertext programs: HyperCard (Macintosh) and LinkWay (MS-DOS). The real difference between the two programs lies in the organisation of the information. HyperCard is a card-based program where the basic unit is the card that can cope with different types of information such as text, sound and images. It provides links to other cards through "buttons" located on the cards. LinkWay is a document-based program and the basic unit of information is the document. Links to other documents and footnotes are embedded in the body of the text. "Buttons" are also a feature of this system.
TABLE 2.4 A COMPARISON OF THE BASIC ORGANISATION OF THE TWO MAIN HYPERTEXT ENVIRONMENTS (AFTER BARKER AND TUCKER, 1990)

<table>
<thead>
<tr>
<th>HyperCard</th>
<th>LinkWay</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>cards</td>
<td>pages</td>
<td>HyperCard presentation limited to the on-screen dimensions of the card</td>
</tr>
<tr>
<td>background card</td>
<td>base page</td>
<td>as above</td>
</tr>
<tr>
<td>stack</td>
<td>folder</td>
<td>size of stacks and folders limited by available memory</td>
</tr>
<tr>
<td>pictures stored on page or separate files</td>
<td>pictures stored in separate files</td>
<td>HyperCard allows text and pictures to be easily manipulated</td>
</tr>
<tr>
<td>objects can be placed anywhere on the card</td>
<td>objects must be placed on an 8-pixel grid</td>
<td>LinkWay limits the positions in which objects can be placed</td>
</tr>
<tr>
<td>full scripting language</td>
<td>limited scripting language</td>
<td>HyperCard has greater options for programming and creating links.</td>
</tr>
<tr>
<td>black and white but colour achievable with special options</td>
<td>colour standard</td>
<td>colour creates interest and creates opportunity for more innovative screen design</td>
</tr>
</tbody>
</table>

**Instructional design**

The instructional design movement developed out of the systems approach used for military training during World War II (Seels, 1989). A pioneer in the field was James Finn (1960) who linked the theory of systems design to educational technology. He made educational technologists aware that technology was as much a process as a product, and described educational technology as a systematic application of knowledge to solve an educational problem (Finn, 1960). Two other pioneers in the field of instructional design were Gagné and Briggs who tackled training problems for the military. They
identified some important research areas such as types of learning, conditions for learning, media characteristics and task analysis, and made large contributions to the knowledge in this field.

Another catalyst that helped to start the instructional design movement was research into programmed learning. It gave impetus to the study of the variables of instruction which became known as design characteristics, and many of today's well known instructional designers began their careers as developers of programmed instruction.

Two important historical events influenced the instructional design and technology movement in the United States. The first was Sputnik in 1957 and the ensuing funds available for the development of large scale curriculum projects, and the second was the effect of the post World War II baby boom which overwhelmed schools with large numbers of students. Centres for instructional development were established to produce instructional materials that could be used by large groups and small groups for independent study. A systems approach was used to guide projects through all stages and emphasis was placed upon design specifications rather than the learner.

By the late 1960's cognitive psychologists such as Jerome Bruner were challenging the behaviourist, programmed instruction movement and were developing their own theories. New curriculum materials such as "Man, a Course of Study" (M.A.C.O.S.) were developed and these emphasised discovery learning and other cognitive processes (Bruner, 1966). At the same time the field of computer assisted learning was moving toward more interactive learning by allowing learners to choose from the available learning
options. By the end of the 1960's the field had expanded from instructional development to instructional design which focused upon how the learner used the software rather than the transmission of knowledge to the learner. This expansion allowed research to be directed at refining instructional design systems by investigating the various steps and evolving different models of learners and the learning tasks. The findings of this research were applied in the 1970's and some significant outcomes were: increased research into evaluation techniques, research on message design, application of systems design processes to new technology, and wide acceptance of the application of educational objectives to the design process (Seels, 1989).

But, not all researchers were convinced that the movement was evolving as it should, and in 1979, DeBloois called for instructional designers to adopt assumptions about themselves and students that were less limiting. He compared the assumptions of past instructional design models with post 1980 instructional design models shown below in Table 2.5. The problem was that many instructional designers were limiting themselves by applying design model assumptions that were pre-1980's. Models based upon an assumption of a homogeneous audience that followed a linear path were outdated or not effective, and future models should be based upon a heterogeneous audience and a mosaic of multi-dimensional developmental materials. These models were required to take advantage of anticipated technological developments such as graphic user interfaces, combinations of different forms of information representation and more powerful personal computers. That is, there were many options available but they were not being used by instructional designers.
<table>
<thead>
<tr>
<th>Current Instructional Design Model Assumptions (pre-1980)</th>
<th>Modern Instructional Design Model Assumptions (post-1980)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Linear development of materials and strategies</td>
<td>Mosaic/multidimensional development of materials and strategies.</td>
</tr>
<tr>
<td>Homogeneous audience planning</td>
<td>Heterogeneous audience planning</td>
</tr>
<tr>
<td>Sequential component development</td>
<td>Interfacing, subsystem development</td>
</tr>
<tr>
<td>One time selection of media and format</td>
<td>Multiple and continuing selection options for media and other materials</td>
</tr>
<tr>
<td>Dominant media emphasis</td>
<td>Eclectic media options</td>
</tr>
<tr>
<td>Limited validation cycles</td>
<td>Unlimited validation cycles</td>
</tr>
<tr>
<td>Separation of resource and presentation material</td>
<td>Integration of resource and presentation materials</td>
</tr>
<tr>
<td>Limited dissemination capacity</td>
<td>Extended dissemination capacity</td>
</tr>
</tbody>
</table>

In 1983 Merrill and Li took a different approach through the development of Component Display Theory which proposed that different types of learning outcomes, classified on a performance dimension, require different types of learning conditions and different content structure. By 1987 this theory was applied to a prototype instructional design expert system. The prototype system called ID Expert (Li and Merrill, 1991), was developed to assist a designer to make instructional design decisions. It was built upon the work of Gagné, Merrill and Reigeluth and assumed that different types of learning outcomes require content to be structured in different ways which may be elaborated or nested within each other. Heuristic algorithms are applied to generate a course organisation, and for each module in the course organisation and instructional strategies, there is a least one transaction that may be appropriate for teaching the content included in the module. The transactions
strategy is dependent upon the characteristics of the student and the content materials involved. The instructional design process associated with this system involves the following steps: gather information about the learners and their requirements, defining instructional goals, develop content structures, generate course organisation, and prescribe at least one transaction strategy. This system indicates a direction that researchers should pursue as such a system has the potential to make instructional design process accessible to the non-expert, providing reliable data can be easily obtained.

The 1980's can be thought of the decade when interactivity became an important consideration in instructional design. It came about in response to new forms of media, the development of graphic user interfaces, and criticism of the design of past instruction. However many of the benefits of these changes are still to come, because teachers and students are limiting themselves and are failing to make novel use of existing media based learning (Gagné, 1987). It is important to find out if there are factors that encourage teachers to use less limiting teaching strategies with educational technology and this study will contribute toward an understanding of this issue.

The 1990's may be the "hypertext decade". Hypertext learning environments promise a great deal but will deliver little if teachers and students are not capable of its effective use. To achieve this goal, research will be needed into the design and use of hypertext by students and teachers (Sewell, 1990). Few teachers have experience with hypertext-based learning environments and, therefore, they lack the skills to facilitate effective student use of this new learning environment. In particular, there is need to retrain teachers so that they can develop skills that facilitate negotiation, goal setting, cooperative
group learning with their students (Litchfield, 1990). This will allow students to take advantage of a growing body of hypertext software. Such teacher training will have to be software based because of limited financial support to inservice training. Therefore it will be important to find ways of using software to train teachers in its effective use.

**Instructional design issues associated with hypermedia**

Hypermedia learning environments use hypertext software to link to multimedia to create an interactive multimedia learning environment. Research by Kearsley and Frost (1985) into interactive multimedia raised issues that may be classified under the broad headings of interactivity, organisation and active participation, video design, metaphors, models and personality, and a team approach. These issues need to be addressed by successful hypermedia applications and will be used as the framework in this discussion. The authors claimed *interactivity, organisation and active participation* were fundamental concepts that link all design factors. *Interactivity*, without appropriate feedback, can mean the user becomes lost and cannot make effective use of the interaction on offer (Hedberg and Harper, 1991). Therefore, the organisation of the media has to be closely related to the interactivity that is designed to occur. Navigation aids are needed, and these can be in the form of help screens, accompanying maps, levels of menus or on-screen icons.

*Active participation* allows for a high level of user involvement when the software allows users to be in control of the pace of instruction, the strategies used, the degree of difficulty of instruction, and the content to be covered. If these features are included, then the user feels that he /she is part of the learning process.
Visual design was considered important because much depends on its effectiveness (Kearsley and Frost, 1985). Many of the design principles are ideas borrowed from animation, video, photography, computer assisted learning and television advertising. Significant issues raised were:

• presenting one main idea per screen.

• avoid cluttering the screen with too much information.

• use a few type styles and sizes to highlight ideas.

• use colour sparingly (and highlight, link or unify).

• organise information functionally on the screen to reduce confusion and unnecessary cognitive processing.

• use graphics and visuals in additional to text whenever possible.

Many of these issues are also closely related to navigation, information processing theory and user interface design.

Metaphors, models and personality. These features provide a mood and unifying theme to an interactive multimedia package and focuses attention on the main concepts. They lead to better understanding of the purpose of the program and motivate the learners (Kearsley and Frost, 1985: 12).

Hannafin and others (1985) also published tentative guidelines for the design of interactive multimedia and these guidelines identified issues of: adaptation and levels of difficulty that challenged learners, video stimuli as a primary
source of instruction, and the application of instructional design theory to the technology. The final issue is fundamental to the instructional success of interactive multimedia because too often the technology is seen as something to be added to enhance or embellish existing instruction.

**Learner control**

Fleschig (1975) showed that learners needed to be in control of rather than controlled by the computer and its software. This allowed the learner to take responsibility for his/her learning rather than following a path prescribed by the software. One of the first concrete demonstrations of the benefits of additional learner control came out of the research of Seymour Papert (1980) when he showed how the programming language of Logo could be used with computers to give learners a feeling that they had control over the computer. It was also claimed to teach children about computers and to facilitate higher-level cognition, but researchers such as Pea and Kurkland (1984) have challenged this contention, claiming that this effect is minimal.

Hartley (1981) suggested that instructional designers need to consider how much learner control over strategies is needed for efficiency. Anandam and Kelly (1981) argued that a balance is required between the need for learners to be active participants and the role an effective teacher can play as a collaborator and co-learner. Therefore the design of the software should be flexible so that the levels of control can be adjusted to suit different styles of learning. Nievergelt (1982) agreed with this philosophy but argued that learners should be given as much control as possible and they should have many possible learning paths available to them. In 1985 Hedberg
and Perry took this argument further by claiming that learners can interact in ways that the designers of the system did not plan and that good instructional design makes it unnecessary to structure materials for the learner.

Other computer-based tools which give users a degree of control such as word processing, desk-top publishing, ideas processors, data bases, graphics packages and programming languages other than Logo have also been proposed as potential supports for the development of general-purpose, high-level cognitive skills (Olson, 1985). So far the evidence does not clearly support the hypothesis that the use of computers to assist learning results in the development of transferable, general cognitive skills (Sewell, 1990), but giving children a feeling of control over the computer is a powerful motivator which encourages children to achieve more than they normally would (Papert, 1980).

As modern instructional design principles were applied to the design of recent interactive multimedia packages, learners were free to explore the material in any order, but several authors (Hedberg, 1988; Scriven and Adams, 1988; Midoro, 1990) have identified emerging problems with:

1. the cognitive demands of navigation systems which allowed large amounts of user control. Inexperienced users, suffered from "cognitive overload" and could not access all the information required (Liebhold 1987; Sewell, 1990; Hedberg and Harper, 1991). Sometimes this was due to badly designed navigation systems, and the use of improved navigation systems was suggested as a way to achieve improved learning outcomes (Hedberg and Harper, 1991; Oren et al., 1990; Sweller, 1988; Ambron and Hooper, 1988, 1990).
2. the use of effective learning paths and sequences. Often learners did not employ effective learning paths when they had control of the learning process (Liebhold 1987, Kaehler 1987, Beynon 1985, Hannafin, 1985). This may be linked to their attempts to apply their cognitive strategies to the knowledge structures represented in the multimedia package (Jonassen, 1988; Franklin, 1988; Balajthy, 1990; Blanchard, 1990; Underwood, 1988). Therefore, instructional designers need to identify the cognitive demands placed upon learners and to devise ways of assisting them through better navigation systems or conceptualised structures.

3. the roles of teachers in the delivery of interactive multimedia packages need to be considered during the instructional design process as ultimately they have the potential to facilitate effective learning with this technology (Balajthy, 1990; Blanchard, 1990).

These findings were supported by Copeland (1987), and by Schaffer and Hannafin (1984) who showed that as interactivity increased, the associated instructional time also increased. They also found that the instructional process became inefficient because learners did not possess the higher-order skills necessary to make informed judgements when they interacted with the instructional material (Carrier, 1984). They accessed large amounts of information that was only peripherally relevant to their main goal and suffered "cognitive overload" (Sewell, 1990). This may mean that the learners were unsure of the information that they have covered and were unsure about what information was left.
The issue of how much student control should be designed into an interactive multimedia program requires further research. This will vary with the context of the learning situation, but there may be an optimum amount of student control necessary for efficient instruction. During this study data will be gathered about the amount of control teachers would permit students when they first use interactive multimedia. This may contribute to an understanding of why past researchers have found that teachers prefer to employ teacher-centred control when they initially use new technology with their students (Hawkins and Sheingold, 1987).

Adopting the technology

Effective use of educational technology can be hampered by enthusiastic advocacy. The following examples are a selection from advocates of computers in the classroom:

"I believe that certain uses of very powerful computational technology and computational, ideas can provide children with new possibilities for learning..." (Papert, 1980: 17).

"Human-computer ... systems will serve to extend and ultimately to reorganise what we think as human imagination, intelligence, problem solving skills and, and creativity" (Pea, 1985).

"The computer is a revolutionary tool that may have the potential to help children to become more intelligent..." (Chaille and Littman, 1985).
The advocacy of recognised researchers is open to misrepresentation by bureaucrats, teachers, parents and computer salespersons who mistakenly believe that most of the problems associated with education could be solved by allocating the bulk of the teaching to machines. As Striebel stated in 1986 a tendency of "delegitimising non-technical ways of learning exists" and there is a parallel with the early hype associated with computer-assisted learning and the articles that appeared advocating interactive multimedia (Hosie, 1987: 5). Brown in 1991 stated, "we are all too often left with the feeling that we have heard all this before". The interest and enthusiasm generated by advocates of interactive multimedia needs to be translated into demonstrable gains in instructional efficiency; otherwise "the greatest risk will be that the computer (and associated interactive multi-media) may be used in ways that do not improve the education system, but lead to further deterioration" (Bork, 1991).

Authors such as Burkman (1987) recognised that despite this interest and enthusiasm many problems associated with CAI and interactive multimedia packages came from the users not adopting the products as the authors intended and this detracts from the delivery of instruction by interactive multimedia. Some reasons for this were:

• the packages did not contain suitable user support in the form of guides and on-screen tutorials. Therefore, teachers and students did not understand the program and were unable to use it effectively.

• the users did not or could not use the support materials provided with the packages. Support material can be too brief or so detailed that it frightens
potential users. One aim of this study was to contribute to a further understanding of the reasons why subjects prefer different forms of support materials.

- the notion that all one had to do was place a child in front of the screen, switch on the machine and learning would automatically occur (this idea stems from the early ideas associated with programmed learning).

- the instructional design model was not flexible enough for adaptation to different learning contexts.

- the product did not live up to the expectations of the user and was inadequate for the teacher's requirements.

- the product was not developed as an integral part of a course.

- there was no provision made to adequately train teachers in the use of the package.

The control given to the users (teachers and students) is a critical factor in the successful implementation of interactive multimedia (Dede, 1987; Marchionini, 1988; Taylor, 1987; Underwood 1988) and studies by Balajthy (1990) and Blanchard (1990) identified the separation of author control versus user control as an issue that needed to be addressed by instructional designers involved with interactive multimedia. Authors such as Gagné, (1987); Kearsley, (1988); Criswell, (1989); Ambron and Hooper, (1988), have attempted to address this issue, but raised concerns about:
• teacher acceptance. Many will feel that their independence is under attack. Therefore there is a need to ensure that teachers can have an input into the direction that learning takes, but at the same time preserving the option of free exploration.

• teacher training. It is reasonable to expect that newly appointed teachers should receive preservice training in current information technology, but there is a pressing need to retrain inservice teachers to accept and use new technology. Winslow (1991) pointed out that the realities of school life are such that many who are responsible for the implementation of information technology in schools are reluctant to spend time with uninitiated colleagues because of the repeated interruptions to their preparation and teaching time. Also inservice teacher training by specialists is expensive and of limited benefit. Where possible technology-base training should be used as a cost-effective way to address these issues.

• past negative experience with educational technology. Sewell (1990) mentions that "the past decade has taught us to be wary of visionaries bearing computer-based gifts" and many educational administrators have experienced problems with the introduction of computers into schools. This coupled with poor quality software and negative teacher attitudes due to lack of training have made them sceptical. There are already over 600 interactive multimedia (videodisc) titles and hundreds of CD-ROM titles available, but there is a danger that the poor quality, low cost packages among these will inhibit the acceptance of this form of instruction.
Effective teaching with the technology

In 1990, Litchfield raised the issues of restructuring the classroom, and extending the role of the teacher, and the student so that more emphasis could be placed upon student-centred learning. This implied that less emphasis should be placed upon the use of traditional teacher-centred strategies such as textbooks and lectures. Bork (1991) supported this view when he suggested that "the simple textbook/lecture system, on which many schools are based, has reached a point where it is no longer improvable". Schools have to rely upon teachers to provide appropriate links between the student and the technology. In particular, teachers will have to match their instructional goals and objectives to what the interactive multimedia program has to offer. Therefore, it is essential for teachers to expand their teaching methodology to place greater emphasis on negotiated learning and cooperative group work (Hawkins and Sheingold, 1987). Simultaneously they will be required to develop with their students, skills that allow them to make effective use of the technology. This requires the teacher to expand the role of students by: encouraging them (with guidance) to set their own pace, encouraging discussion, decision making and goal setting, and the teaching of group management and cooperative learning skills.

The adoption of new technology in isolation is unlikely to be effective and it needs to be kept in mind that many of the new computer and videodisc technologies fail to address current problems of educational systems such as: inappropriate teaching methods and systems of organisation (Bork, 1991). In the past innovators have assumed that teachers would alter their methods to accommodate technological advances but this has not been the case. Even if
teachers can see real benefits for themselves and their students, many are unlikely to change their teaching methods (Bork, 1991; Hawkins and Sheingold, 1987).

Bosco (1984) suggested that re-organising certain subjects into modules (similar to industrial training modules) may be a more efficient way of using the technology. Such a process requires curriculum reorganisation and the vertical semester organisation of curriculum (Middleton, 1982; Ferry, 1988) has been a way of achieving Bosco's suggestion. However a weakness of this approach is that it relies on changes in the organisational structure of schools to change the way teachers work and this has not been effective in the past (Sharpe, 1992).

Another approach has been to build teacher training into an interactive video package. That is, educate teachers through the technology. The strengths of this approach are:

- teachers experience first hand the strengths of interactive multimedia.
- the module can "stand alone" and be available for referral.

A disadvantage of the "through the technology" approach lies with the need to have access to all the required equipment. Teacher support booklets with an interactive multimedia package may be a more productive alternative as booklets can be used anywhere and at any time. Another approach might be to produce a hypertext, electronic booklet that teachers could use with their classroom computer. This approach may be more satisfactory as copies are easily made and many users can have access to the electronic booklet
simultaneously. Little research has been undertaken to study the effect of the training strategies and the accompanying support material on training teachers to employ the technology; but if some form of initial teacher training in interactive multimedia is needed, then it is important to consider how should it be structured so that teachers feel comfortable with the technology.

Some schools have employed specialist computer teachers who have the task of working with teachers inexperienced with computers. The aim is to teach them the skills needed to be effective with computers in their classrooms. Weaknesses of this approach are: the lack of suitable personnel to meet the demand (Winslow, 1991), and the lack of release time for teachers to meet and learn from each other, and the cost of providing release time.

**Summation**

Interactive multimedia is only one form of instructional delivery. The goal is to improve teaching and learning, and simply embracing this new technology is unlikely to lead to success. Appropriate support must be given to the delivery of this form of instruction if it is to be used in the classroom, and support should be given to the teacher as well as the learner.

There are two problems related to effective teacher training in interactive multimedia that will be addressed by this study. One is the identification by teachers of the instructional strategies allowed by interactive multimedia, and the other is the training of teachers to employ innovative teaching strategies so that the learners can take full advantage of the technology.
Identifying interactive multimedia instructional strategies

Teachers may be unable to identify the instructional strategies allowed by interactive multimedia because they have difficulty understanding the cognitive structures of the learning material available. Furthermore, they may then have difficulties relating this cognitive structure to the structure of curriculum knowledge that they posses. For example, the multimedia program used in this study was structured so that learners could use text, pictures and video to construct a multimedia report about the topic of animal migration, but teachers may not direct learners to use this powerful learning tool because they are unaware of it, or feel that it is not relevant to their teaching context. Pre-instructional strategies such as advanced organisers can provide teachers a general overview of the teacher-support material to help teachers understand the structure of the support learning material provided and assist them to relate this potentially useful learning materials to their existing cognitive structure (Ausubel, 1960; 1963).

The advanced organisers used in this study were designed to help subjects to understand the structure of the learning support material available and how it could be employed in a teaching context. Novice users of hypertext often suffer from "cognitive overload" which hampered its effective use (Leibhold, 1987; Sewell, 1990; Hedberg and Harper, 1991). Also the findings of Hannafin et al., 1985; Hannafin and Hughes, 1986; Reynolds and Anderson, 1982; Hannafin et al., 1982, had shown that orienting activities often motivate users of interactive multimedia by alleviating concerns relating to the perceived difficulty of forthcoming instruction. Teachers who are unfamiliar with interactive multimedia may find advanced organisers of use because, in
general, the power of advanced organisers increases as the availability of prerequisite knowledge and quality of lesson organisation decrease (Mayer, 1976, 77, 79). It was anticipated that few (if any) subjects would have previous experience with interactive multimedia.

Some forms of advanced organisers that have been used in the past were: comparative textual passages in the form of brief paragraphs (Ausubel and Youssef, 1963), thematic titles and sentences (Merrill and Stolurow, 1966), lists that guide the performance of a task (Mayer, 1977), graphic organisers such as pictures or diagrams (Alvermann, 1981), and diagrams illustrating the relationships among task components to central ideas (Mayer, 1975). Comparative textual passages, thematic titles and sentences can alert the reader to key ideas and establish a link to the material that follows, but lists that guide performance are able to indicate what is to be learnt. In this study a table of teaching and organisational strategies was used for this purpose.

A graphic organiser may provide in picture form a map of how the materials are structured and organised. If the organiser is designed carefully so that the relationships between the various pieces of information are easy to see, then it is likely to be of use to the learner. In this study the graphic organiser used was a navigation map of the booklet and the hypertext support. The teacher support materials used in this study were themselves an advanced organiser for the learning material supplied in the interactive multimedia program. The text and diagrams included in both forms of teacher support material alerted the reader to main activities available and establish a link to the sections of the program that related to these activities.
Training teachers to employ innovative teaching strategies

There is a strong case for research into ways of assisting teachers to adopt interactive multimedia in the classroom because interactive multimedia is about to become a tool used for work and leisure. Even though there has been increased research in instructional design theory over the last 20 years and findings have been applied to the production of interactive multimedia programs, little attention has been paid to the training and support of the teachers who will use interactive multimedia with learners. This approach may have resulted from a tendency to make programs "teacher proof" because in the past teachers have not always used the programs as they were intended (Burkman, 1987). This ignores the role played by teachers who motivate students, and supplement and support the program. Also it does not support the proposition that it is likely that teachers who are confident in using this new instructional medium will more readily transfer their positive experience into effective teaching with interactive multimedia.

The adoption of innovations by teachers has been studied by many researchers. Havelock (1982) and Rogers (1986), identified an adoption process which involves a number of phases. Havelock identified the following phases:

1. awareness the individual is exposed to the innovation;

2. interest the individual actively seeks information about the innovation;
3. **evaluation** mental trial of the innovation;

4. **trial** the individual trials the innovation;

5. **adoption** the results of the trial are considered and a decision made to adopt or reject the innovation;

6. **integration** even if a decision is made to adopt the innovation, it cannot be considered to take place until it becomes routine.

The training process employed during this study was based upon this model. Phases 1 and 2 were combined to introduce the interactive multimedia program, phases 3 and 4 were combined and teacher-subjects trialed the program, and phases 5 and 6 were combined and modified so that teacher-subjects could consider applying the experience to their teaching context. Table 2.6 summarises this process.
TABLE 2.6  A PROCESS OF TRAINING IN INTERACTIVE MULTIMEDIA  
AFTER HAVELock, (1982)

<table>
<thead>
<tr>
<th>Phase</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction</td>
<td>demonstration of the program using features that instil curiosity. This section should be brief, easy to understand and rewarding</td>
</tr>
<tr>
<td>Trial</td>
<td>the program is used in a non-threatening, relaxed environment where subjects are free to follow their own interests</td>
</tr>
<tr>
<td>Application and Integration</td>
<td>advanced organisers and support material are provided. The subjects are then directed to complete a task related to how the program may be applied to the classroom. This phase allows subjects to &quot;envision the innovation applied in their own situation.&quot;</td>
</tr>
</tbody>
</table>

Katz and Offir (1988) have shown that when computers are introduced into the classroom, teachers have to effect changes in their teaching methods and classroom organisation so that the technology can be accommodated efficiently into the instructional process. But Glasman and Nevo (1988) have shown that only those teachers who feel comfortable with novel and innovative teaching methods are likely to react positively toward the use of computers in the classroom. In 1990 Offir and Katz showed that risk-taking attitudes was a personality trait that was significantly interconnected with a positive attitude toward the use of computers in the classroom. This study followed up these findings and related them to interactive multimedia by examining the relationships between the teaching strategies subjects choose with interactive multimedia and risk-taking attitudes, attitudes to computers, and the subject's use of the support material provided.
Research questions arising from this review of the literature

The following research questions were raised as a result of this literature review and are the subject of this study:

1. What identifiable strategies did the teachers employ in working through the interactive multimedia support materials? What search paths did they take?

2. Did the three phase training process assist teachers to plan effective teaching strategies with interactive multimedia?

3. Did the use of different forms of teacher support material lead to differences in planning outcomes and attitudes toward the technology?

4. What was the effect of the advanced organisers upon the training process and its outcomes?

5. Did the time spent with the instructional material affect teaching strategies selected?

6. What type and variety of teaching strategies do teachers employ when they begin using this technology? What are the consequences of these choices?
Objectives of the study

The objectives following arose from the research questions and the review of the literature. These objectives, as well as the research questions, guided the formulation of the hypotheses listed in the next chapter.

Objectives

1. To identify forms of instruction that are effective in training subjects to use interactive multimedia.

2. To evaluate the effectiveness of two forms of support material developed to assist teachers in selecting teaching strategies to use with interactive multimedia.

3. To identify factors that encourage teachers to use interactive multimedia.

4. To describe the search paths subjects use to locate information related to teaching strategies with interactive multimedia.

5. To evaluate the effectiveness of the advanced organisers.

6. To identify teaching strategies subjects prefer with interactive multimedia.
CHAPTER 3 METHODOLOGY

Interactive multimedia learning packages contain stored information in the form of text, sound and images, as well as user support material, and software designed to allow the learner to interact with stored information to achieve desired learning outcomes.

During this study subjects were required to complete a planning process that a typical teacher might use when developing lesson plans for a section of an interactive multimedia package. The effects of the two forms of support material were compared so that the findings could provide suggestions about refining the design of these materials in the future.

The development of strategies to study these issues and others relating to the research questions will be the subject of this chapter.

Experimental materials

The interactive multimedia package used for this study was Interactive Nova- "Animal Pathfinders" distributed by Scholastic Publications in collaboration with Apple Computers (1990). The package was designed for children from ages 10 to 16 years and used an ecology theme. It contained 2 double sided videodiscs of stored audio visual material, several HyperCard stacks, and system software stored on magnetic disks. Support materials included were: a handbook, teachers guides, and icon and navigation charts. Simplified forms of the support materials were created for this study because the original support materials contained information that was not needed by novice users of interactive multimedia.
The package was chosen from several others because:

- it could be used by both primary and secondary teachers.

- it could be used in a wide variety of teaching contexts.

- it was designed to allow novice instructors/students to become successful users of the package in minimum time.

- it was possible to apply the themes and activities across a range of subject disciplines.

The package was presented to a small number of undergraduate students to determine which features of the program would convey required information in the most economical and efficient manner. The material selected for presentation to subjects demonstrated the main features of the program that were applicable to children who were from 10 to 16 years old. Also the subject matter chosen was not specific to one domain of knowledge as it was hypothesised that such a presentation would be interpreted by most subjects as relevant to the context of their teaching. The features presented were at a cognitive level that was easy for all subjects to comprehend.

Subjects

The subjects of this study were volunteer postgraduates (experienced teachers) and undergraduate seniors (trainee teachers). Originally, 11 pairs were selected from a sample of the postgraduate group, and 13 pairs from the undergraduate seniors group, making a total of 48 subjects. The pairing of subjects was arranged by mutual agreement as
previous studies had shown that supportive pairs assist each other in learning new skills (Ramsden, 1992). One subject (or pair) from each group withdrew from the experiment.

The post-graduate group was enrolled in an introductory research methods course which is a compulsory component of a Masters in Education Degree. They were selected to ensure that the sample contained representatives of: experienced and inexperienced computer users, both sexes and a range of ages as shown in Table 3.1.

Undergraduate subjects were volunteer students from second and third year enrolled in a Bachelor of Teaching (Primary) Degree. They had just completed three weeks of practice teaching. Therefore they had recent classroom experience to reflect upon when they were selecting teaching strategies. Details of the sample selected is shown in Figure 3.1.

Table 3.1 summarises the data about the subjects who completed the experiment.

<table>
<thead>
<tr>
<th>TABLE 3.1 SUBJECT DATA</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Subjects</strong></td>
</tr>
<tr>
<td>Undergraduate</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Postgraduate</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Totals</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

A Chi-Square analysis of the frequencies in the cells in the bottom row indicated that the total sample did not have any inherent bias.
Treatment

At the start all pairs were given pre-treatment questionnaires plus a 30 minute demonstration of the main features "Animal Pathfinders" program. Each 30 minute demonstration was given by the researcher who followed the same sequence each time. Care was taken to ensure that the demonstration took the same time for each pair of subjects. After this demonstration, pairs of subjects were allowed 30 minutes of practice with the features of the interactive multimedia package previously demonstrated. No instruction was provided during the practice period.

After the practice session, the paired subjects were issued with a table, that listed the topics available ways of organising the class, teaching methods and matching menus from the program. A section of this table is shown in table 3.2.

**TABLE 3.2 SECTION OF THE PLANNING TABLE**

<table>
<thead>
<tr>
<th>Topic</th>
<th>Class organisation</th>
<th>Teaching method</th>
<th>Matching menu from the program</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bee Dances</td>
<td>whole class</td>
<td>lecture/explanation</td>
<td>overviews</td>
</tr>
<tr>
<td>Protective Colouration</td>
<td>small groups</td>
<td>video presentation</td>
<td>database</td>
</tr>
<tr>
<td>Turtle Mystery</td>
<td>in pairs</td>
<td>class discussion</td>
<td>activities</td>
</tr>
<tr>
<td>Beaver Pond</td>
<td>individual use</td>
<td>small group discussion</td>
<td>resources</td>
</tr>
<tr>
<td>Animal Migration</td>
<td></td>
<td>problem solving</td>
<td></td>
</tr>
</tbody>
</table>
The table contained five possible themes, lists of teaching methods and organisational strategies, as well as headings from the sub-menus of the interactive multimedia package. The suggestions about class organisation and teaching methods were based upon those made by participants who trialed the program plus recommendations made by researchers in computer-based instruction such as Bork (1984, 1991); Callen (1991) and Geiser (1982). Subjects were able to use this table at any time when they were planning lessons.

Subjects were also issued with a navigation map of the support material shown in Figure 3.1. They were advised that they could use the map to help them find their way around the support materials.
One subject received support package A (Hypertext support) and the other subject received support package B (support booklet). Experienced and inexperienced computer users were divided as evenly as possible among the different support materials.
All subjects were then given the following task to complete:

"Imagine that you are teaching in a co-educational school and have an upper primary or junior secondary class of twenty five to thirty mixed ability students. The students have been trained to use a Macintosh computer and are capable of switching it on, and using a mouse. The table provided lists five themes from the "Animal Pathfinders" program. Listed in the columns, adjacent to the topics, are various forms of class organisation and teaching methods which could be used when teaching with "Animal Pathfinders". The final column contains the names of the sub-menus of the program. Each submenu in this column may contain activities and materials that directly relates to the theme you choose.

Use the information provided in the support material and reflect upon the introduction you had to the program. Select one topic from the list and then select appropriate strategies for teaching this topic to the class described. Record your choices on the table as shown in the example (shown in Table 3.3). Use lines to link class organisation, teaching methods and the menus in the final column. Consider carefully all the options and include all that you would use. Also include additional teaching strategies that you would use that are not listed. A description of the teaching methods listed is provided in a table (see table 3.4) so that we all understand what they are.

Please do not discuss this research with fellow students until I have completed this task with all students. A special de-briefing session will then be held with all participants."

After completing this task subjects were asked to complete a post-session questionnaire and to verify and comment upon written observations made by the researcher.
The table shows a sequence of three lessons (labelled 1, 2 and 3) that introduce the program to students. Lesson one used whole class lecture/demonstration and made use of the overviews sub-menu. The arrows show that both lessons two and three made use of the database sub-menu, but used different ways to organise the class and different teaching methods.

As each subject searched through the support material, the researcher mapped the paths taken. Subjects using the booklet were required to point to each sub-menu as they read it so that the researcher could accurately map their search path. Sub-menu headings contained the relevant icon from the package and were clearly labelled in fourteen point font, bold print. This made the task of following the search path easier. The map used to record the search path was the same as the navigation map. A cross was drawn at the subject's starting point and lines with arrows were drawn on the map to show the search paths taken. Subjects were also asked to verbalise their thoughts so that this information could also be recorded. A tape recorder was tried, but
subjects indicated that the presence of the tape recorder made them nervous. Instead the observer made notes, and verified the notes after the task was completed.

TABLE 3.4 THE TEACHING METHODS LISTED IN THE QUESTIONNAIRE AND SELECTION TABLE

<table>
<thead>
<tr>
<th>Teaching method</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>• whole class lecture/demonstration.</td>
<td>the teacher presents the information to the whole class in a deductive way that is illustrated by teacher selected examples. Also the teacher may demonstrate how to perform a specific task.</td>
</tr>
<tr>
<td>• whole class guided discovery.</td>
<td>the lesson is presented by the teacher in an inductive way, using a questioning strategy that elicits students' responses to the teacher selected stimuli. Students discover the learning objectives for themselves and help direct the course of the lesson.</td>
</tr>
<tr>
<td>• small group cooperative learning.</td>
<td>students work in cooperative learning groups of three or four.</td>
</tr>
<tr>
<td>• paired or individual hands on activity.</td>
<td>students work in pairs or individually on tasks that involve manipulation of equipment.</td>
</tr>
<tr>
<td>• independent research.</td>
<td>students work in pairs or individually on their own research.</td>
</tr>
</tbody>
</table>

The Support Packages

Teacher support package A - Hypertext support

This stack contained the same information as the teachers support booklets but the information was organised so that subjects could use a mouse to "click" on-screen buttons to link to cards of related information. The information contained in these stacks consisted of brief descriptions of specific features of the package, suggested lessons plans, and student worksheets.
The HyperCard stack and booklet contained identical information about:

- how to begin using the interactive multimedia package, a diagram showing the hardware, plus brief information about the main menus of the system.

- examples of lesson plans for five topics of the interactive multimedia package which included: learning objectives, suggestions for class organisation, specified learning tasks for students, lists of follow up activities.

- information about the subject matter relating to the five topics above for inexperienced teachers.

- examples of student worksheets for the five topics above.

Included with the HyperCard support material was a simple navigation map.

*Mapping the start of the search path with HyperCard*

A single card showing equipment required was used as a starting point. This card displayed buttons that could be clicked on to take a subjects to their chosen sub-menu. The first sub-menu chosen was taken as the starting point of the search.

*Teacher support package B - teacher support booklet*

This contained the same information found in the HyperCard stack.
The material was organised in a booklet containing a contents page and tab markers. It was also accompanied by the same navigation map as with the HyperCard stack.

**Experimental design**

The design of the study is summarised below:

<table>
<thead>
<tr>
<th>Undergraduate seniors sample</th>
<th>Postgraduate sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>$S_1 \ 0_1 \ XX_A \ 0_2 \ 0_3$</td>
<td>$S_2 \ 0_1 \ XX_A \ 0_2 \ 0_3$</td>
</tr>
<tr>
<td>$S_1 \ 0_1 \ XX_B \ 0_2 \ 0_3$</td>
<td>$S_2 \ 0_1 \ XX_B \ 0_2 \ 0_3$</td>
</tr>
</tbody>
</table>

**Key**

- $S_1$ = undergraduate subjects.
- $S_2$ = postgraduate sample.
- $0_1$ = pre-treatment questionnaire.
- $0_2$ = observation of subjects using the support material.
- $0_3$ = post-treatment questionnaire.
- $X$ = common demonstration and follow up lessons with interactive multimedia.
- $X_A$ = treatment A (navigation map, table plus teacher support package A - electronic text)
- $X_B$ = treatment B (navigation map, table plus teacher support package B - booklet)

**Method**

**Pre-treatment questionnaire**

Before the experiment a pre-questionnaire was administered to collect information about each subject's gender, teaching experience, attitude
to computers, computing experience, knowledge of the teaching syllabus for their subject, preferred degree of learner control, and attitudes to risk-taking.

Attitude to computers and computing experience could be considered to be inter-related, but prior to starting the experiment, several undergraduate subjects who were studying one semester subject in computer literacy, claimed that this experience had a negative effect upon their attitude to computers. Therefore, the two factors were considered separately.

An expected limitation with the questionnaire items about classroom management was the differences between the stated intentions of the teachers and their actual practices. Post-treatment interviews with twelve subjects were used to triangulate (verify) this data.

*The instructional planning task*

This task, described previously, is a simulation of a task required of a teacher who intended to use the "Animal Pathfinders" program for class instruction.

*Post-treatment questionnaire*

The post-experiment questionnaire contained some similar items to the pre-experimental questionnaire. These were used to find out if subjects had changed their previous responses.
Variables

The independent variables were:

- the two types of teacher support materials.
- gender.
- teaching experience.
- attitudes to computers.
- computing experience.
- self-reported knowledge of the teaching syllabus for their subject.
- degree of learner control measured in the pre-treatment questionnaire.
- attitudes to risk taking.

The dependent measures were:

- degree of learner control preferred with interactive multimedia.
- the subjects' ratings of the teacher support material.
- the time to complete the instructional planning task. From when the subject began to use the support material to when they completed the planning task.
• the number of times subjects referred to the navigation map during the instructional planning task.

• the number of teaching strategies selected.

• the frequency of referrals to the sub-menus in the instructional materials.

Operational definitions

1. Users are the persons who operate the package. They are:

   • teachers who instruct students so that they can use the interactive multimedia package for learning.

   • students who use the interactive multimedia package for the purpose of learning. Their access to the interactive multimedia package is controlled by their teacher.

2. Control of the interactive multimedia system is defined as the freedom users have to decide when and how instruction from the interactive multimedia system is delivered.

3. Degree of learner control of the instructional process.

Control of learning can be:

   • teacher-centred control when all students are engaged in a teacher defined and chosen learning task for more than 50% of the time.
• *student-centred control* when all students are engaged in a student defined and chosen learning task for more than 50% of the time.

The following indicators of student-centred control were included in the questionnaire:

• between student(s) discussions. Such discussions were about the learning task but were between two or more students.

• student manipulation of equipment. Students were able to operate equipment independently of the teacher.

• students engagement in cooperative learning tasks. Students worked in cooperation in pairs or small groups to complete a learning task.

• student choice of learning tasks and working groups.

Response options to questions about the amount of class time given to these indicators were:

1 = never.

2 = less than 25% the time.

3 = between 25 and 50% of the time.
4 = between 50 and 75% of the time.

5 = more than 75% of the time.

Teaching strategies consist of two components: the organisation of instruction and teaching methods.

Instruction can be organised as whole class instruction, small group instruction or an individual basis. Small groups may be formed by:

- student selection where the students select the members of the group on more than 50% of occasions, or by

- teacher selection where the teacher selects the members of the group on more than 50% of occasions,

5. Use of audio-visual teaching aids used.

Teachers indicated how frequently they used audio-visual aids with classes.


Teachers indicated on a five point Likert scale the amount of classroom interaction that they would like to use with interactive multimedia lessons.
7. Demographic data

This data was collected by a questionnaire. Questions were about:

- *gender*

- *teaching experience* was defined in terms of years of teaching experience.

Experienced teachers had taught five or more years and inexperienced teachers had taught less than five years. This classification does not take into account the variety of teaching experience as it is possible for a teacher to have repeated experience with a very narrow range of children and syllabuses. Questions about the subject's knowledge of the teaching syllabus were designed to elicit some of this information.

8. The computing experience was divided into self-ranked categories (modified from Becker, 1983). These categories were:

*Inexperienced:* the subject occasionally used a computer for basic word processing.

*Experienced:* the subject regularly used a computer to prepare documents and record marks and could confidently use word processing and draw programs.

9. Attitudes to computers was based upon a five point Likert scale. The instrument was based upon one used by Bear, Richards and Lancaster (1987).
10. **Knowledge of the teaching syllabus** was the subject's self-rating of his/her knowledge of the prescribed syllabuses in their subject area. Subjects were asked to rate their syllabus knowledge as: current or adequate. If their syllabus knowledge was *current*, subjects were confident that they fully understood all sections of the syllabuses they taught and they were up to date with the latest ideas and changes. If their syllabus knowledge was *adequate*, subjects were familiar with the syllabuses they taught but were not up to date with latest ideas and changes.

11. **Risk taking attitudes** The instrument was a modification of a Likert scale used by Offir and Katz (1990). Two of their original questions were modified to an Australian context. Analysis of pilot study data showed that the substituted items had a higher correlation (.68, .59,) with the total score than the original two items (.43, 41). Therefore the modified items were included in the final questionnaire. The unmodified items had correlations of more than .5 with the total score.

12. **Teaching strategies selected**.

Subjects chose a specific topic from five options. Then they selected combinations of methods of class organisation and teaching from the options available. Space was left to include additional strategies not included in the original list. The total number of options recorded by each subject was used to measure the number of different teaching strategies they would employ.

13. **Match of teaching strategies to the program menus.**
Each subject recorded on a selection table the combinations of teaching strategies selected to deliver their chosen theme. They then matched their selection(s) with the sub-menu options that they felt would deliver the strategies chosen. Every link was given a score of one and links that were clearly not achievable a score of zero.

14. Rating of the support material (HyperCard support, booklet support).

In the post-questionnaire, 9 questions were used to find out how subjects rated the support material they used.

Follow up interviews

Twelve subjects were interviewed to triangulate the data. Six were from the post-graduate group and six were from the undergraduate group.

Research Hypotheses

H1 the rating of the support material will be higher for subjects who are inexperienced teachers than those who are experienced teachers.

H2 the rating of the HyperCard support will be higher for subjects who are experienced computer users than those who are inexperienced computer users.

H3 the rating of the support booklet will be higher for subjects who are inexperienced computer users than those who are experienced computer users.
H4 the rating of the support material will be higher for female subjects than male subjects.

H5 the degree of learner control that teachers allow with the "Animal Pathfinders" program will be greater for those who use HyperCard support than those who use support booklets.

H6 the degree of learner control subjects would allow with the "Animal Pathfinders" program will be greater if they rate themselves as experienced teachers.

H7 the degree of learner control subjects would allow with the "Animal Pathfinders" program will be greater if they rate themselves as experienced computer users.

H8 the degree of learner control subjects would allow with the "Animal Pathfinders" program will be greater if they rate their knowledge of the syllabuses they teach as current.

H9 the degree of learner control subjects would allow with the "Animal Pathfinders" program will be greater if they score high on the risk-taking questionnaire.

H10 the degree of learner control subjects select in the post-treatment questionnaire will be lower than that selected in the pre-treatment questionnaire.

H11 subjects who use HyperCard support will make more links between selected teaching strategies and supporting sub-menus than those who use booklets.
H12 the number of teaching strategies selected by subjects who use HyperCard support will be greater than those who use support booklets.

H13 the number of teaching strategies subjects select will be greater if they rate themselves as experienced teachers.

H14 the number of teaching strategies subjects select will be greater if they rate themselves as experience computer users.

H15 the number of teaching strategies subjects select will be greater if they rate their knowledge of the teaching syllabuses for their subject as current.

H16 the number of teaching strategies subjects select will be greater if they already employ a wide variety of teaching methods.

H17 the number of teaching strategies subjects select will be greater if they scored high on the risk-taking questionnaire.

H18 the time taken to complete the instructional planning task will be longer for subjects who use the HyperCard support.

H19 the number of times that subjects refer to the navigation map will be greater if they use HyperCard support.

H20 the proportion of 'yes' responses to the statement: 'the navigation map was useful' will be greater from subjects who used the HyperCard support.
H21 topics chosen by subjects who used the booklet support will be different to those who used the HyperCard support material.

Questionnaire responses were analysed using the statistical program "StatView" (Abacus concepts, 1989). The scoring of questionnaire responses was: 1-strongly disagree, 2-disagree, 3-undecided, 4-agree, 5-strongly agree. All ratings were coded so that one was the lowest response and five the highest response. Negative questionnaire items were coded in reverse. Where appropriate, interaction between independent variables were tested by two-way ANOVA.

Pilot Studies

Pilot studies were undertaken in preparation for this study. First there was an informal study with a group of 10 Diploma of Education students studying science methods in 1991. They were instructed in how to use the technology to access the interactive multimedia package but were not given any assistance in appropriate ways to use the package. At the end of a ninety minute session a group discussion was held. This discussion revealed that the subjects had little trouble in navigating around the interactive multimedia package but they all stated that they needed further instruction to choose appropriate teaching strategies to use with children. They also indicated that they thought the package required at least thirty minutes of instruction and thirty minutes of practice.
A week after this introductory session these trainee teachers were asked to complete a trial questionnaire containing questions arising from the previous weeks discussion. Their responses are summarised in Appendix 1.

A second study involved 15 undergraduate B.Ed. (primary) students. A post-treatment questionnaire identical to that used with the previous group was administered. The results of this survey also appear in the Appendix 1. In general responses were positive and indicated that the package was easy to use. A phobia of computers expressed by one student was followed up by an informal class survey which revealed that between one third and half of the trainee teachers felt uneasy about using computers.

Trial forms of the final questionnaires were also administered and responses analysed to assess the validity of individual items. Items that scored a correlation of less than .5 with the total score were deleted from the final questionnaire (Tuckerman, 1988). Procedures for data analysis were trialed and it was decided that the scores for items that were related to the same variable should be added as shown in Openheim (1992) and Tuckerman (1988).

A third study was a modified version of the second study involving three undergraduate trainee teachers studying secondary science education. Subjects were given a trial form of the teacher support booklet to use with the "Animal Pathfinders" interactive multimedia package. Written observations of this treatment session were recorded and verified by post treatment interviews.
CHAPTER 4 RESULTS AND ANALYSIS

The subjects for this study were required to complete a planning process that typical teachers might use when they were developing lessons using section of an interactive multimedia package. The effect of two forms of support material are compared to provide suggestions about the design of future teacher support materials.

This chapter begins with a summary that shows how the data was organised, and the results of statistical tests. Individual hypotheses and data relating to attitudes to computers are analysed and discussed. Observational data and comments are summarised and discussed, and maps of typical search patterns taken by subjects as they used the support material are analysed. The chapter concludes with a summary of the findings. A full table of descriptive statistics for each questionnaire item is provided at the start of Appendix 9.

Organisation of data

The questionnaires

Scores for questions relating to specific variables and hypotheses were aggregated (added) after negative items had been reverse scored. ANOVA tests were applied to hypotheses 1-8, 11-15, 19, and regression analyses to hypotheses 9, 16, 17, 18 (as these hypotheses contained variables measured from the aggregation (sum) of nine or more questionnaire items, and the resulting distribution, by virtue of the central limit theorem, approximated normality). Because of the size of the sample, tests for interactions were between pairs of factors only.
A t-test was used to test hypothesis 10 and Chi-Square analysis was applied to hypothesis 20;

Table 4.1 shows how the questionnaire items were aggregated (added). The numbers in the right-hand column refer to number of individual items from the questionnaires. The number in the left-hand column refers to the hypothesis(es) tested by the aggregation (sum) of scores for these items. For example the score for questionnaire items 61 to 69 related to the rating of the support material and was used to test hypotheses 1 to 4. Each of hypotheses 1 to 4 tested a relationship between this score and an independent variable (e.g. for hypothesis 1 the independent variable was teaching experience).

**TABLE 4.1 ORGANISATION OF DATA**

<table>
<thead>
<tr>
<th>Hypotheses tested</th>
<th>Questionnaire items aggregated (added)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,2,3,4</td>
<td>61-69</td>
</tr>
<tr>
<td>5,6,7,8</td>
<td>47-52, 55,56,58, 59, 60</td>
</tr>
<tr>
<td>9</td>
<td>23-32; 47-52, 55,56,58, 59, 60</td>
</tr>
<tr>
<td>10</td>
<td>6,7,8,9,11,13,14,15,16,18 (10 items) pre-test</td>
</tr>
<tr>
<td></td>
<td>47-52,53,55,56,58 (10 identical items) post-test</td>
</tr>
</tbody>
</table>

*Other hypotheses tested*

For hypothesis 11, the number of links between selected teaching methods and the sub-menus that supported these strategies from the multimedia program were totalled for each subject. For hypothesis 12, the total of the teaching strategies (teaching methods and organisational strategies)
selected by subjects was used. Attitudes to computers were measured by aggregating (adding) scores on questionnaire items 33 to 46 and risk-taking was measured by aggregating items 23 to 32.

Summary of Results for Hypotheses Tested

Table 4.2 following shows the results of the statistical tests used for data analysis, where statistically significant findings were found. Analysis and discussion about all individual hypotheses follow this table. Hypothesis 21 could not be tested by Chi-Square analysis as the expected frequency in some cells was less than 5. Therefore, the results were compared and discussed.

TABLE 4.2 SUMMARY OF STATISTICALLY SIGNIFICANT FINDINGS (p<.05)

<table>
<thead>
<tr>
<th>Hypothesis</th>
<th>Results of Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>F(1,44) = 6.809, p = .0124 ANOVA</td>
</tr>
<tr>
<td>4</td>
<td>F(1,44) = 4.98, p = .0311 ANOVA</td>
</tr>
<tr>
<td>10</td>
<td>45 df, t = 2.012, p = .0252 t-test</td>
</tr>
<tr>
<td>11</td>
<td>F(1,44) = 10.816, p = .002 ANOVA</td>
</tr>
<tr>
<td>12</td>
<td>F(1,44) = 16.808, p = .0002 ANOVA</td>
</tr>
<tr>
<td>18</td>
<td>F(1,44) = 13.25, p = .0008 ANOVA</td>
</tr>
<tr>
<td>20</td>
<td>$X^2$(1) = 14.653, p = .0001 Chi-Square</td>
</tr>
</tbody>
</table>

Hypotheses 1, 4, 10, 11, 12, 18 and 20 were statistically significant at the 5% level of significance. Therefore, seven of the twenty one hypotheses tested were significant at the 5% level of significance.
Hypotheses results and discussion

Hypothesis 1

"The rating of the support material will be higher for subjects who are inexperienced teachers than those who are experienced teachers."

The null hypothesis was rejected and hypothesis 1 accepted ($F(1,44) = 6.809, p = .0124$). The mean and standard deviation for experienced and inexperienced teachers were 30.762, 6.292 and 34.56.3.367 respectively.

The following comments made by inexperienced teachers supported the hypothesis:

"I prefer to use printed text but I didn't have any trouble using the computer support materials."

"I didn't have any trouble using the computer support materials."

"I found the computer support easy to use."

"The computer program was easy to use but I know of friends who I'm sure would prefer to use a booklet."

"Even though I hate computers, I could manage this program."

"I have no particular preference about support. I would prefer to have a combination of booklet and computer support."
To triangulate (verify) observations, post-interviews were held with 6 inexperienced teachers: three who used the booklet and three who used the HyperCard support. Subjects who used the HyperCard support considered it to be easy to use because the buttons allowed them to move backwards and forwards through cards and menus. Also they liked the novelty of using cards on the screen, but two subjects also stated that a booklet would be useful when they did not have access to a computer. Subjects who used the booklet felt that it helped them, but commented that the HyperCard option also appeared to be useful for the reasons mentioned previously. These subjects also stated that both forms of support were probably needed.

Hypothesis 2

"The rating of the HyperCard support material will be higher for subjects who are experienced computer users than those who are inexperienced computer users."

The null hypothesis was retained (F(1,44) = .086, p = .7704). Comments made by subjects support these findings. Many commented about the ease of use and novelty of the HyperCard support, but it was not considered to be more useful than the booklet form of support. This may indicate that both forms of support are needed to accommodate for the preferred learning styles of subjects.
Hypothesis 3

"The rating of the support booklet will be higher for subjects who are inexperienced computer users than those who are experienced computer users."

The null hypothesis was retained (F(1,44) = .146, p = .7043). Again, this result may indicate that both forms of support may be needed to accommodate the different learning styles of subjects; or that the deep structure of the support materials was the same.

Hypothesis 4

"The rating of the support material will be higher for female subjects than male subjects."

The null hypothesis was rejected and hypothesis 4 accepted (F(1,44) = 4.98, p = .0311). The two-way ANOVA table 4.3 showed that the interaction between factors of gender and computer experience was not significant, but the main effect of gender was significant at the 5% level of significance. The incident table shows that females rated the support material higher than the males.
TABLE 4.3 TWO-WAY ANOVA TABLE OF INTERACTION BETWEEN GENDER AND COMPUTER EXPERIENCE

Anova table for a 2-factor Analysis of Variance on Y 1: Rating Support mat. 97-105

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>F-test</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender (A)</td>
<td>1</td>
<td>126.627</td>
<td>126.627</td>
<td>4.978</td>
<td>.0311</td>
</tr>
<tr>
<td>Computer experience (B)</td>
<td>1</td>
<td>227</td>
<td>227</td>
<td>.009</td>
<td>.9251</td>
</tr>
<tr>
<td>AB</td>
<td>1</td>
<td>63.287</td>
<td>63.287</td>
<td>2.488</td>
<td>.1222</td>
</tr>
<tr>
<td>Error</td>
<td>42</td>
<td>1068.404</td>
<td>25.438</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

There were no missing cells found.

The AB Incidence table on Y 1: Rating Support mat. 97-105

<table>
<thead>
<tr>
<th>Computer experience</th>
<th>Experienced</th>
<th>Inexperienced</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>14</td>
<td>10</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td>33.143</td>
<td>35.7</td>
<td>34.208</td>
</tr>
<tr>
<td>Male</td>
<td>14</td>
<td>8</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>32.143</td>
<td>29.875</td>
<td>31.318</td>
</tr>
<tr>
<td>Totals</td>
<td>28</td>
<td>18</td>
<td>46</td>
</tr>
<tr>
<td></td>
<td>32.643</td>
<td>33.111</td>
<td>32.826</td>
</tr>
</tbody>
</table>

Other interactions

Interactions between gender and teaching experience (F(1,42) = .879, p = .357), gender and syllabus knowledge (F(1,42) = .007, p = .9346), and syllabus knowledge and teaching experience (F(1.42) = 1.188, p = .282) were not significant.
Subjects who had adequate syllabus knowledge rated the support material more highly than those who had current syllabus knowledge. Subjects with adequate syllabus knowledge, may have found the support material more helpful than subjects who have current syllabus knowledge, but this difference could also be accounted for by other factors such as teaching ability, creativity and motivation, different search patterns (to be discussed later in the chapter) and random variability of responses.

The nine questionnaire items about the value of the support materials were aggregated. The score for each subject could vary from 9 (the lowest rating) to 45 (the highest rating). The histograms following show how the male and female scores were distributed across this scale. Female scores started at 26 and ended at 46 (mean 34.208, S.D. 4.24). Most females rated the support material above the mid-point of 27. There was a similar distribution for males (mean 30.435, S.D. 7.115) except for four post-graduate subjects who gave a negative rating to the support material. Three were experienced with computers (1 computer consultant, 2 teachers of computing), and in their case only part of the support material was needed. The fourth male subject who gave the lowest rating to the support material (booklet) stated that he did not like using the booklet and found the material of little use.
FIGURE 4.1  FEMALE RATING OF THE SUPPORT MATERIALS

FIGURE 4.2  MALE RATING OF THE SUPPORT MATERIALS
The findings are supported by the following quotes from post-treatment interviews:

"I have no particular preference about support. I would prefer to have a combination of booklet and computer support." (female-booklet user)

"The information as presented 'eased' me into the task. A video presentation about teaching with interactive multimedia would help. I feel that the HyperCard system allowed me to follow my natural curiosity." (Male-HyperCard user)

"After observing people with the HyperCard stack I felt that it was easier to use than the booklet, but I was still able to find the information needed." (Male-booklet user)

"I could use the HyperCard, but I would have liked to have seen a video of a class using this equipment." (Female-HyperCard user)*

"After using the booklet, I would have liked to have been able to link to the laser disc so that I could call up examples again." (Male-booklet user)

"Both methods are O.K. but I think in the long run the computer will be less time consuming than flicking through pages." (Female-booklet user)

"I found the computer support easy to use." (Female-HyperCard user)
* This comment was also made by subjects who participated in the pilot study and it seems that some subjects need to see a model of how the program can be employed in a classroom.

**Hypothesis 5**

"The degree of learner control that teachers allow with the "Animal Pathfinders" program will be greater for those who use HyperCard support than those who use support booklets."

The null hypothesis was retained ($F(1,44) = .0006, p = .9407$). One explanation is that when teachers are using new technology with learners, they tend to use teaching strategies that are not as learner-centred, as there is less risk associated with implementing teacher-centred strategies.

**Hypothesis 6**

"The degree of learner control subjects would allow with the "Animal Pathfinders" program will be greater if they rate themselves as experienced teachers."

The null hypothesis was retained ($F(1,44) = .334, p = .5604$). Interactions between the factors of gender, computer experience, teaching experience, syllabus knowledge and support material used were tested by two-way ANOVA. Table 4.4 following lists the pairs of factors tested.
TABLE 4.4 PAIRS OF FACTORS TESTED FOR INTERACTION BY TWO-WAY ANOVA

<table>
<thead>
<tr>
<th>Factor 1</th>
<th>Factor 2</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>gender</td>
<td>computer experience</td>
<td>$F(1,42) = .71, \ p = .404$</td>
</tr>
<tr>
<td>gender</td>
<td>teaching experience</td>
<td>$F(1,42) = .275, \ p = .605$</td>
</tr>
<tr>
<td>gender</td>
<td>syllabus knowledge</td>
<td>$F(1,42) = 2.645, \ p = .113$</td>
</tr>
<tr>
<td>computer experience</td>
<td>teaching experience</td>
<td>$F(1,42) = .474, \ p = .495$</td>
</tr>
<tr>
<td>computer experience</td>
<td>syllabus knowledge</td>
<td>$F(1,42) = 1.447, \ p = .2358$</td>
</tr>
<tr>
<td>teaching experience</td>
<td>syllabus knowledge</td>
<td>$F(1,42) = .221, \ p = .6408$</td>
</tr>
<tr>
<td>support material used</td>
<td>computer experience</td>
<td>$F(1,42) = .43E-4, \ p = .9838$</td>
</tr>
<tr>
<td>support material used</td>
<td>teaching experience</td>
<td>$F(1,42) = 1.86, \ p = .1799$</td>
</tr>
<tr>
<td>support material used</td>
<td>syllabus knowledge</td>
<td>$F(1,42) = .89, \ p = .351$</td>
</tr>
<tr>
<td>support material used</td>
<td>gender</td>
<td>$F(1,42) = .433, \ p = .574$</td>
</tr>
</tbody>
</table>

No interactions of the above factors were significant.

The score for learner control was based upon the aggregation of 11 questionnaire items which resulted in a scale that started at 11 (least learner control) and ended at 55 (most learner control). The means and standard deviations for experienced teachers and inexperienced teachers were 23.5 (S.D. 4.5) and 24.6 (S.D. 4.2) respectively. There was no statistically significant difference between these means but they were below the mid-point of 33 and indicated that most subjects favour some form of teacher-centred control. Histograms of responses were plotted, and the histogram for experienced teachers had 19 responses between 31 and the lower point of the scale, with only one response above the mid-point of 33. Thus, the majority of experienced teachers preferred teacher-centred control of learning. The one subject who preferred learner-centred control had taught for 23 years in secondary school science and was known for her innovative style of teaching.
The histogram for inexperienced teachers had only 1 subject that was above the mid-point on the scale. This indicated that the inexperienced teachers also favoured teacher-centred control and had very similar attitudes toward the control of learning. For this sample, it is unlikely that increased experience with teaching alone, will lead to greater learner-centred control.
FIGURE 4.4 INEXPERIENCED TEACHERS AND CONTROL OF LEARNING

Hypothesis 7

"The degree of learner control subjects would allow with the "Animal Pathfinders" program will be greater if they rate themselves as experienced computer users."

The null hypothesis was retained ($F(1,44) = .012, p = .9122$). For the sample studied, it is unlikely that additional experience with computers will lead to a shift in the degree of control they allow learners.
Hypothesis 8

"The degree of learner control subjects would allow with the "Animal Pathfinders" program will be greater if they rate their knowledge of the syllabuses they teach as current."

The null hypothesis was retained (F(1,44) = .939, p = .3379). Again, for the sample studied, it is unlikely that additional syllabus knowledge will lead to a shift in the degree of control they allow learners.

Hypothesis 9

"The degree of learner control subjects would allow with the "Animal Pathfinders" program will be greater if they score high on the risk-taking questionnaire."

The null hypothesis was retained F(1,44)= 1.893, p=.1755. Regression analysis was used to test the predictor variables of teaching experience and gender with the criterion variable of risk-taking, and the results of this analysis are summarised in table 4.5. There was a significant effect for the variable of teaching experience p= .0252 and approximately 11% of the variation in risk taking could be explained by this factor. The inexperienced teachers were more likely to take risks (mean 26.12, S.D. 4.531) than experienced teachers (mean 29.714, S.D. 5.985). This may be a function of age as the experienced teachers were older than the inexperienced teachers.
TABLE 4.5 REGRESSION ANALYSIS OF THE PREDICTOR VARIABLE OF TEACHING EXPERIENCE AND RISK TAKING

Simple Regression $x_2$ : Teaching experience  $y_1$ : RISK Tot

<table>
<thead>
<tr>
<th>Count</th>
<th>R</th>
<th>R-squared</th>
<th>Adj. R-squared</th>
<th>RMS Residual</th>
</tr>
</thead>
<tbody>
<tr>
<td>46</td>
<td>.33</td>
<td>.109</td>
<td>.088</td>
<td>5.242</td>
</tr>
</tbody>
</table>

Analysis of Variance Table

<table>
<thead>
<tr>
<th>Source</th>
<th>DF</th>
<th>Sum Squares</th>
<th>Mean Square</th>
<th>F-test</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>REGRESSION</td>
<td>1</td>
<td>147.444</td>
<td>147.444</td>
<td>5.366</td>
<td>.0252</td>
</tr>
<tr>
<td>RESIDUAL</td>
<td>44</td>
<td>1208.926</td>
<td>27.476</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TOTAL</td>
<td>45</td>
<td>1356.37</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

No Residual Statistics Computed

Figure 4.6 shows the distribution of responses across the risk-taking scale that started at 10 (those who were willing to take risks) and ended at 50 (those who were not willing to take risks). The mid-point of the scale was 30.
Hypothesis 10:

"The degree of learner-control subjects select in the post-treatment questionnaire will be lower than that selected in the pre-treatment questionnaire."

A one-tailed, paired t-test was used to test this hypothesis and the results are summarised in Table 4.6.

**TABLE 4.6 RESULTS OF A PAIRED T-TEST FOR HYPOTHESIS 11**

<table>
<thead>
<tr>
<th>Paired t-Test X: PRE CONTROL</th>
<th>Y: POST CONTROL</th>
</tr>
</thead>
<tbody>
<tr>
<td>DF:</td>
<td>45</td>
</tr>
<tr>
<td>Mean X - Y:</td>
<td>1.196</td>
</tr>
<tr>
<td>Paired t value:</td>
<td>2.012</td>
</tr>
<tr>
<td>Prob. (1-tail):</td>
<td>.0252</td>
</tr>
</tbody>
</table>
The null hypothesis was rejected and hypothesis 10 accepted \((t = 2.012, p = .0252)\). The mean score for the 10 post-treatment questionnaire items was less than the mean scores on the same items in the post-treatment questionnaire. A possible explanation is that subjects prefer teacher-centred control when they initially use new methods of instructional delivery (Hawkins and Sheingold, 1987). Other reasons may be related to insecurity in dealing with pupil-centred learning and/or to insecurity with new technology.

The preference for teacher-centred control was confirmed during debriefing interviews, and most subjects stated that they wanted to be in control of the learning tasks until they were confident that pupils were capable of working independently.

**Hypothesis 11**

"Subjects who use HyperCard support will make more links between selected teaching strategies and supporting sub-menus than those who use booklets."

The null hypothesis was rejected and hypothesis 11 accepted, \((F(1,44) = 10.816, p = .002)\). Table 4.7 shows the total number of links between the selected teaching strategies and the supporting sub-menus of the program. It is divided so that each form of support material can be compared.


**TABLE 4.7 TOTAL NUMBER OF LINKS BETWEEN TEACHING STRATEGIES AND SUPPORTING SUB-MENUS OF THE PROGRAM**

<table>
<thead>
<tr>
<th>Sub-menu</th>
<th>Booklet support</th>
<th>HyperCard support</th>
</tr>
</thead>
<tbody>
<tr>
<td>overviews</td>
<td>14</td>
<td>16</td>
</tr>
<tr>
<td>database</td>
<td>16</td>
<td>16</td>
</tr>
<tr>
<td>activities</td>
<td>10</td>
<td>18</td>
</tr>
<tr>
<td>resources</td>
<td>8</td>
<td>14</td>
</tr>
</tbody>
</table>

While the numbers are small and caution is needed in interpreting these results, it does appear that fewer booklet users made use of the supporting sub-menus. First-time users of such a complex program are unlikely to be familiar with these features and they may have required more time and interaction with the program to understand these features. Users of the HyperCard support may have been advantaged because they viewed this unfamiliar information on cards that could be linked by buttons. Booklet users received the information in normal text and had to flip back and forth through the pages to make the same links.

It is possible that unfamiliar procedural information is easier for subjects to understand because the HyperCard environment allows subjects to use buttons to link information together into "chunks" (Merrill, 1987). This effect called "chunking", is associated with the organisation of items into clusters of ideas called "chunks". While this effect has been investigated since 1953 (Bousfield), this suggestion needs further investigation in this context.

Each subject's teaching strategies with the interactive multimedia program will vary according to the topic chosen, the preferred teaching style, and the cognitive processing of the available information. In order to fully use the features of the interactive multimedia program, subjects have to
cognitively process the information into teaching strategies which take advantage of the educational strengths of this technology. To be effective in this cognitive processing task, subjects have to define goals, and then find and link various pieces of information together to form an effective teaching strategy. Such a process would involve the process of "chunking", and in this case "chunking" may be better supported by the hypertext than a normal text.

**Hypothesis 12**

"The number of teaching strategies selected by subjects who use HyperCard support will be greater than those who used the booklet support."

The null hypothesis was rejected and hypothesis 12 accepted (F(1,44) = 16.008, p = .0002). Subjects who used HyperCard support selected an average of 7 strategies compared with 4.9 for subjects who used the booklet. The same information was supplied to both groups of subjects, but the different outcomes may be due to a combination of factors such as the novelty of the HyperCard support, the structure of the hypertext support, extra time taken or an interaction between these factors. Also the context of previous teaching experience may have influenced this outcome.

Table 4.8 lists the frequency of the teaching strategies selected. Teaching strategies consisted of two parts: the class organisation and teaching method(s). Subjects were advised that they could use the same classroom organisation with more than one teaching method, and similarly, the same teaching method could be used with more than one way of classroom
organisation. They were instructed to only choose teaching strategies that they would use.

**TABLE 4.8 FREQUENCY OF TEACHING STRATEGIES SELECTED**

<table>
<thead>
<tr>
<th>Class organisation</th>
<th>Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>whole class</td>
<td>38</td>
</tr>
<tr>
<td>small groups</td>
<td>33</td>
</tr>
<tr>
<td>in pairs</td>
<td>14</td>
</tr>
<tr>
<td>individual use</td>
<td>11</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Teaching method</th>
<th>Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>video presentation</td>
<td>37</td>
</tr>
<tr>
<td>problem solving</td>
<td>29</td>
</tr>
<tr>
<td>class discussion</td>
<td>26</td>
</tr>
<tr>
<td>small group discussion</td>
<td>25</td>
</tr>
<tr>
<td>guided discovery</td>
<td>23</td>
</tr>
<tr>
<td>production of a multimedia report</td>
<td>21</td>
</tr>
<tr>
<td>teacher instruction</td>
<td>13</td>
</tr>
</tbody>
</table>

The reasons for the high number of subjects favouring a combination of "whole class" and "video presentation" might include: traditional, teacher-centred strategies are employed to introduce the program because the teachers feel strategies are likely to be the most effective at the start of a topic or, the teachers feel that the strategies give them greater control over an unfamiliar learning situation. There is also a danger that teachers may use the material like a sequential video player and make little use of the real potential of the program (table 4.13 which shows the teaching strategies chosen seems to support this explanation).

Teaching strategies that use whole-class video presentations may not support topics that encourage individual self-exploration, and they may even put at risk some of the important learning outcomes associated with processes of self-directed learning. The number of subjects who chose to
organise classes in pairs or as individuals was small compared to whole class and small group organisation, and some subjects combined whole class and small group organisation with topics that were meant to be supported by methods which individualised instruction.

Again, this apparent mis-match may be related to an initial need of subjects to have teacher-centred control. Hawkins and Sheingold (1987) examination of computers and the organisation of learning in classrooms supports this view. They showed that, with time, the role of the teacher changes as both students and teachers become more familiar with the software. Often teachers begin by demonstrating and explaining then move toward a monitoring and resource-person role. With time, teachers may change the way they organise their classes with interactive multimedia from teacher-centred strategies to those which require greater individual or paired use.

The variety of teaching strategies employed by the nine subjects who were given an additional two hours to explore all aspects the program and use all of the support material ranged from a maximum of twelve to a minimum of one, but the mean of 6.6 was not significantly greater than before (mean 6.4). Therefore, for this group of nine subjects, the additional time taken and extra resource material did not produce any noticeable increase in teaching strategies selected, but they selected strategies that allowed children to work as individuals, pairs or groups rather than as a whole class. They also linked these strategies to sub-menus of the program that supported self-exploration (simulations, database exploration, construction of audio-visual reports), and appeared to have identified the strengths of the program.
Hypothesis 13

"The number of teaching strategies subjects select will be greater if they rate themselves as experienced teachers."

The null hypothesis was retained (F(1, 44) = 0.0002, p = .9824). Table 4.9 shows how the selected teaching strategies related to teaching experience. Responses by inexperienced teachers are in italics.

**TABLE 4.9 SELECTED TEACHING STRATEGIES OF EXPERIENCED TEACHERS AND INEXPERIENCED TEACHERS (ITALICS)**

<table>
<thead>
<tr>
<th>Class organisation</th>
<th>Responses</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Experienced</td>
<td>Inexperienced</td>
<td></td>
</tr>
<tr>
<td>whole class</td>
<td>21</td>
<td>17</td>
<td></td>
</tr>
<tr>
<td>small groups</td>
<td>14</td>
<td>19</td>
<td></td>
</tr>
<tr>
<td>in pairs</td>
<td>7</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>individual use</td>
<td>7</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Teaching method</td>
<td>Responses</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Experienced</td>
<td>Inexperienced</td>
<td></td>
</tr>
<tr>
<td>video presentation</td>
<td>21</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>class discussion</td>
<td>1</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>small group discussion</td>
<td>13</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>problem solving</td>
<td>16</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>guided discovery</td>
<td>13</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>production of a multimedia report</td>
<td>11</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>teacher instruction</td>
<td>5</td>
<td>8</td>
<td></td>
</tr>
</tbody>
</table>

The distributions of responses by inexperienced and experienced teachers were very similar, and for this sample, the inexperienced teachers did not make significantly different choices to the experienced teachers. Again,
one explanation is that subjects prefer strategies that allow teacher-centred control when they initially use new methods of instructional delivery. Interactions between the factors of gender, computer experience, teaching experience, syllabus knowledge and support material used were tested by two-way ANOVA. Table 4.10 following lists the pairs of factors tested.

**TABLE 4.10 PAIRS OF FACTORS TESTED FOR INTERACTION BY TWO-WAY ANOVA**

<table>
<thead>
<tr>
<th>Factor 1</th>
<th>Factor 2</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>gender</td>
<td>computer experience</td>
<td>F(1,42) = .5575, p = .35</td>
</tr>
<tr>
<td>gender</td>
<td>teaching experience</td>
<td>F(1,42) = .6, p = .4428</td>
</tr>
<tr>
<td>gender</td>
<td>syllabus knowledge</td>
<td>F(1,42) = 3.20, p = .0807</td>
</tr>
<tr>
<td>computer experience</td>
<td>teaching experience</td>
<td>F(1,42) = 1.092, p = .302</td>
</tr>
<tr>
<td>computing experience</td>
<td>syllabus knowledge</td>
<td>F(1,42) = .007, p = .9328</td>
</tr>
<tr>
<td>teaching experience</td>
<td>syllabus knowledge</td>
<td>F(1,42) = 2.181, p = .1472</td>
</tr>
<tr>
<td>support material used</td>
<td>computer experience</td>
<td>F(1,42) = .25, p = .6196</td>
</tr>
<tr>
<td>support material used</td>
<td>teaching experience</td>
<td>F(1,42) = 2.235, p = .1424</td>
</tr>
<tr>
<td>support material used</td>
<td>syllabus knowledge</td>
<td>F(1,42) = .106, p = .746</td>
</tr>
<tr>
<td>support material used</td>
<td>gender</td>
<td>F(1,42) = .151, p = .6899</td>
</tr>
</tbody>
</table>

All interactions were not significant at the 5% level of significance, but the factors of gender and syllabus knowledge had a probability value of .0807. Table 4.11 following is a full analysis of the two-way ANOVA test for these two factors and shows that more males rated their syllabus knowledge as current than females. Further investigation of this interaction with a larger sample is justified.
TABLE 4.11 TWO-FACTOR ANALYSIS OF THE INTERACTION OF
SYLLABUS KNOWLEDGE AND GENDER WITH TEACHING
STRATEGIES SELECTED

Anova table for a 2-factor Analysis of Variance on Y 1: Total.Strat selected

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>F-test</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Syllabus Knowl. (A)</td>
<td>1</td>
<td>3.613</td>
<td>3.613</td>
<td>1.029</td>
<td>.3162</td>
</tr>
<tr>
<td>Gender (B)</td>
<td>1</td>
<td>39</td>
<td>39</td>
<td>.083</td>
<td>.7752</td>
</tr>
<tr>
<td>AB</td>
<td>1</td>
<td>11.248</td>
<td>11.248</td>
<td>3.204</td>
<td>.0807</td>
</tr>
<tr>
<td>Error</td>
<td>42</td>
<td>147.437</td>
<td>3.51</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

There were no missing cells found.

The AB Incidence table on Y 1: Total.Strat selected

<table>
<thead>
<tr>
<th>Gender</th>
<th>Female</th>
<th>Male</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>current</td>
<td>9</td>
<td>8</td>
<td>17</td>
</tr>
<tr>
<td>Syllabus</td>
<td>5.899</td>
<td>6.75</td>
<td>6.294</td>
</tr>
<tr>
<td>adequate</td>
<td>15</td>
<td>14</td>
<td>29</td>
</tr>
<tr>
<td></td>
<td>6.333</td>
<td>5.143</td>
<td>5.759</td>
</tr>
<tr>
<td>Totals</td>
<td>24</td>
<td>22</td>
<td>46</td>
</tr>
<tr>
<td></td>
<td>6.167</td>
<td>5.727</td>
<td>5.957</td>
</tr>
</tbody>
</table>

Hypothesis 14

"The number of teaching strategies subjects select will be greater if they rate themselves as experience computer users."

The null hypothesis was retained (F(1,44) = .078, p = .7813). Again, the analysis of selections showed little variation between inexperienced computer users and experienced computer users.
Hypothesis 15

"The number of teaching strategies subjects select will be greater if they rate their knowledge of the teaching syllabuses as current."

The null hypothesis was retained ($F(1,44) = .84, p = .3642$). The descriptor "current" was chosen because many syllabus have changed or are about to change. Also syllabus support documents are placing increased emphasis upon the use of varied teaching strategies that individualise learning (BSE, 1989). For this sample, there was no significant difference between subjects who had current knowledge of their teaching syllabus(es) and those who have only adequate syllabus knowledge. One possible explanation is that many teachers have "current" knowledge of their teaching syllabuses but few actually apply this knowledge to their teaching. It could also depend on the reliability of teachers' self-assessment of their knowledge of the syllabus.

Hypothesis 16

"The number of teaching strategies subjects select will be greater if they already employ a wide variety of teaching methods."

The null hypothesis was retained ($F(1,44) = .659, p = .4214$). As discussed previously, most subjects did not already employ a wide variety of teaching methods.
Hypothesis 17

"The number of teaching strategies selected will be greater if they score high on the risk-taking questionnaire."

The null hypothesis was retained ($F(1,44) = .1.962, p = .1683$).

Hypothesis 18

"The time taken to complete the instructional planning task will be longer for subjects who used the HyperCard support."

The null hypothesis was rejected and hypothesis 22 accepted ($F(1, 44) = 13.25, p = .0008$).

Regression analysis of this data showed that approximately 25% of the variation in the time taken for the task can be attributed to the form of support material ($R^2 = 24.7$) but, other variables were not accounted for. The increased time taken by subjects who used the HyperCard support may be explained by one or a combination of the following:

- the novelty aspect of the HyperCard medium encouraged subjects to explore the support material for a longer period of time.

- it took longer to read print on the computer screen than from printed text.

- navigation difficulties affected the rate at which subjects progressed through the material.
• subjects who were inexperienced computer users took longer than the experienced users. This explanation was rejected as a t-test of means had a probability of .516.

• subjects who used HyperCard support took longer because they made more referrals to the sub-menus than those who used the booklet. One way Anova was used to test this factor. The result was $F(1, 44) = 29.611, p = .0001$ and, the type of support material provided did have an effect on the number of referrals made. The means and standard deviations for the number of referrals to the booklet and the HyperCard were 30.6, 5.94 and 43, 10.03 respectively. However, there could be other factors associated with the use of the support material that need to be considered. Especially the fact that it is more difficult to see the corpus of information with HyperCard than with a booklet.

Table 4.12 shows the results of two-way ANOVA used to test for interaction between the pairs of factors listed with the time taken for the task.
TABLE 4.12  TWO WAY ANALYSIS FOR THE INTERACTION OF THE FACTORS LISTED AND THE TIME TAKEN FOR THE TASK

<table>
<thead>
<tr>
<th>Factor 1</th>
<th>Factor 2</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>gender</td>
<td>computer experience</td>
<td>F(1,42) = 7.48, p = .0091*</td>
</tr>
<tr>
<td>gender</td>
<td>teaching experience</td>
<td>F(1,42) = .029, p = .8667</td>
</tr>
<tr>
<td>gender</td>
<td>syllabus knowledge</td>
<td>F(1,42) = .322, p = .5733</td>
</tr>
<tr>
<td>computer experience</td>
<td>teaching experience</td>
<td>F(1,42) = 2.318, p = .1354</td>
</tr>
<tr>
<td>computing experience</td>
<td>syllabus knowledge</td>
<td>F(1,42) = .028, p = .8679</td>
</tr>
<tr>
<td>teaching experience</td>
<td>syllabus knowledge</td>
<td>F(1,42) = .046, p = .8303</td>
</tr>
<tr>
<td>support material used</td>
<td>computer experience</td>
<td>F(1,42) = .017, p = .8963</td>
</tr>
<tr>
<td>support material used</td>
<td>teaching experience</td>
<td>F(1,42) = 2.324, p = .1349</td>
</tr>
<tr>
<td>support material used</td>
<td>syllabus knowledge</td>
<td>F(1,42) = 2.94, p = .0938</td>
</tr>
<tr>
<td>support material used</td>
<td>gender</td>
<td>F(1,42) = .054, p = .8176</td>
</tr>
</tbody>
</table>

The interaction between gender and computer experience was significant (p = .0091) at the 5% level of significance. Table 4.13 below shows the two-way ANOVA table for this interaction. Inspection of the incidence table showed that males who were inexperienced with computers took less time than subjects in the other categories.
TABLE 4.13 TWO-WAY ANOVA ANALYSIS OF THE INTERACTION OF GENDER AND COMPUTER EXPERIENCE WITH TIME TAKEN FOR THE TASK

Anova table for a 2-factor Analysis of Variance on Y, 1: Time for task

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>F-test</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computer experience (A)</td>
<td>1</td>
<td>10.738</td>
<td>10.738</td>
<td>1.098</td>
<td>.3007</td>
</tr>
<tr>
<td>Gender (B)</td>
<td>1</td>
<td>22.665</td>
<td>22.665</td>
<td>2.318</td>
<td>.1354</td>
</tr>
<tr>
<td>AB</td>
<td>1</td>
<td>73.154</td>
<td>73.154</td>
<td>7.48</td>
<td>.0091</td>
</tr>
<tr>
<td>Error</td>
<td>42</td>
<td>410.734</td>
<td>9.779</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

There were no missing cells found.

The AB Incidence table on Y, 1: Time for task

<table>
<thead>
<tr>
<th>Gender:</th>
<th>Female</th>
<th>Male</th>
<th>Totals:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experienced</td>
<td>14</td>
<td>14</td>
<td>28</td>
</tr>
<tr>
<td>14.5</td>
<td>15.65</td>
<td>15.075</td>
<td></td>
</tr>
<tr>
<td>Inexperienced</td>
<td>10</td>
<td>8</td>
<td>18</td>
</tr>
<tr>
<td>16.1</td>
<td>12.062</td>
<td>14.306</td>
<td></td>
</tr>
<tr>
<td>Totals:</td>
<td>24</td>
<td>22</td>
<td>46</td>
</tr>
<tr>
<td>15.167</td>
<td>14.345</td>
<td>14.774</td>
<td></td>
</tr>
</tbody>
</table>

The males who were experienced with computers took more time than those who were inexperienced. A tendency for some male users of the HyperCard support to rush was noted during observations, and this may be related to these findings. The data was re-examined to see if there was any relationship between the time taken for males, using the same support material and the links made between selected teaching strategies and the sub-menus that support these strategies. The sample was too small for any statistically significant relationship to be found. Similarly, no statistically significant results were found for the females.
Hypothesis 19

"The number of times that subjects refer to the navigation map will be greater if they use HyperCard support."

TABLE 4.14 TWO-WAY ANOVA ANALYSIS OF THE INTERACTION OF THE FACTORS LISTED WITH REFERRAL TO THE NAVIGATION MAP

<table>
<thead>
<tr>
<th>Factor 1</th>
<th>Factor 2</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>gender</td>
<td>computer experience</td>
<td>F(1,42) = 5.599, p = .0227*</td>
</tr>
<tr>
<td>gender</td>
<td>teaching experience</td>
<td>F(1,42) = .337, p = .5648</td>
</tr>
<tr>
<td>gender</td>
<td>syllabus knowledge</td>
<td>F(1,42) = 2.213, p = .1433</td>
</tr>
<tr>
<td>computer experience</td>
<td>teaching experience</td>
<td>F(1,42) = 2.323, p = .1342</td>
</tr>
<tr>
<td>computing experience</td>
<td>syllabus knowledge</td>
<td>F(1,42) = .218, p = .643</td>
</tr>
<tr>
<td>teaching experience</td>
<td>syllabus knowledge</td>
<td>F(1,42) = 1.201, p = .2794</td>
</tr>
<tr>
<td>support material used</td>
<td>computer experience</td>
<td>F(1,42) = .274, p = .6032</td>
</tr>
<tr>
<td>support material used</td>
<td>teaching experience</td>
<td>F(1,42) = 2.406, p = .1284</td>
</tr>
<tr>
<td>support material used</td>
<td>syllabus knowledge</td>
<td>F(1,42) = 3.52, p = .0676**</td>
</tr>
<tr>
<td>support material used</td>
<td>gender</td>
<td>F(1,42) = .097, p = .753</td>
</tr>
</tbody>
</table>

The interaction between gender and computer experience was significant (p=.0227) at the 5% significance level.

The interaction between support material and syllabus knowledge was close to the chosen probability level (p=.0676) and further investigation with a larger sample should be considered.

The descriptive statistics in table 4.15 support the hypothesis, but the numbers are small and a follow up study with a larger sample over a longer period of time is needed.
TABLE 4.15 DESCRIPTIVE STATISTICS OF THE NUMBER OF
REFERRALS TO THE NAVIGATION MAP

<table>
<thead>
<tr>
<th></th>
<th>X1 : Booklet - Refs to map</th>
<th>X2 : Computer - Refs to map</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>1.5</td>
<td>2.727</td>
</tr>
<tr>
<td>Std. Dev.</td>
<td>.59</td>
<td>1.162</td>
</tr>
<tr>
<td>Std. Error</td>
<td>.12</td>
<td>.248</td>
</tr>
<tr>
<td>Variance</td>
<td>.348</td>
<td>1.351</td>
</tr>
<tr>
<td>Coef. Var.</td>
<td>39.318</td>
<td>42.613</td>
</tr>
<tr>
<td>Count</td>
<td>24</td>
<td>22</td>
</tr>
</tbody>
</table>

Minimum: 1 | Maximum: 3 | Range: 2 | Sum: 36 | Sum of Sqr.: 62 | Missing: 0

Minimum: 1 | Maximum: 5 | Range: 4 | Sum: 60 | Sum of Sqr.: 192 | Missing: 2

An ANOVA test of the means had a probability of <.05 (F(1,44)=33.2). Therefore, the difference was statistically significant.

During observations, subjects with HyperCard indicated that they were using the map to help them to decide where they would go to next in the stack. Some appeared to use the main menu card as a navigation aid and this aspect of the findings will be discussed later. Booklet users glanced at the map at the start but rarely looked it again until they had finished reading.

Hypothesis 20

"The proportion of 'yes' responses to the statement: 'the navigation map was useful' will be greater from subjects who used the HyperCard support."

Chi-Square analysis of the responses are shown in the Table 4.16. The null hypothesis was rejected and hypothesis 20 accepted ($X^2 (1) = 14.653$, p <.01).
<table>
<thead>
<tr>
<th>DF:</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Chi-Square:</td>
<td>14.653</td>
</tr>
<tr>
<td>$p = .0001$</td>
<td></td>
</tr>
<tr>
<td>G Statistic:</td>
<td>15.537</td>
</tr>
<tr>
<td>Contingency Coefficient:</td>
<td>.492</td>
</tr>
<tr>
<td>Phi:</td>
<td>.564</td>
</tr>
<tr>
<td>Chi-Square with continuity correction:</td>
<td>12.478</td>
</tr>
<tr>
<td>$p = .0004$</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Booklet</th>
<th>Computer</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>19</td>
</tr>
<tr>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td><strong>Totals</strong>:</td>
<td>24</td>
</tr>
</tbody>
</table>

0 = "no" response  
1 = "yes" response

<table>
<thead>
<tr>
<th>Booklet</th>
<th>Computer</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>12.52</td>
</tr>
<tr>
<td>1</td>
<td>11.48</td>
</tr>
<tr>
<td><strong>Totals</strong>:</td>
<td>24</td>
</tr>
</tbody>
</table>

0 = "no" response  
1 = "yes" response

Comments made by subjects during de-briefing indicated that the map helped the HyperCard users to navigate around the material, and usually it was not needed with the booklet.
Hypothesis 21

"Topics chosen by subjects who used the booklet support will be different to those who used the HyperCard support material."

Chi-Square analysis could not be used because some of the expected frequencies were less than 5, but comparison of the topics chosen is shown in table 4.17. As mentioned previously the main difference did not lie in the topics chosen but in the way subjects would use the program to support the topics.

**TABLE 4.17 FREQUENCY DISTRIBUTION OF TOPICS CHOSEN**

<table>
<thead>
<tr>
<th>Topic</th>
<th>Booklet support</th>
<th>HyperCard support</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beaver pond</td>
<td>7</td>
<td>4</td>
<td>11</td>
</tr>
<tr>
<td>Animal migration</td>
<td>2</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Bee dances</td>
<td>5</td>
<td>3</td>
<td>8</td>
</tr>
<tr>
<td>Protective colouration</td>
<td>3</td>
<td>5</td>
<td>8</td>
</tr>
<tr>
<td>Turtle mystery</td>
<td>7</td>
<td>8</td>
<td>15</td>
</tr>
</tbody>
</table>

The most popular topic was "The Turtle Mystery" which is a story-based activity that requires problem solving skills. Users must make use of graphics, animation, database information and video clips to solve the mystery. Because the activity was in the form of a game, subjects felt that this topic would be popular with young children.

**Attitudes to computers**

Stepwise regression was used to test relationships between the predictor variables of gender, teaching experience, computer experience and the
syllabus knowledge with the criterion variable of attitudes to computers. Table 4.18 shows the results of these tests.

TABLE 4.18 STEPWISE REGRESSION ANALYSIS FOR ATTITUDES TO COMPUTERS

<table>
<thead>
<tr>
<th>Stepwise Regression Y 1:Att. Comput 4 X variables</th>
<th>Summary Information</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>F to Enter</td>
</tr>
<tr>
<td></td>
<td>F to Remove</td>
</tr>
<tr>
<td></td>
<td>Number of Steps</td>
</tr>
<tr>
<td></td>
<td>Variables Entered</td>
</tr>
<tr>
<td></td>
<td>Variables Forced</td>
</tr>
</tbody>
</table>

No Residual Statistics Computed

<table>
<thead>
<tr>
<th>Stepwise Regression Y 1:Att. Comput 4 X variables</th>
<th>Analysis of Variance Table</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Source</td>
</tr>
<tr>
<td></td>
<td>REGRESSION</td>
</tr>
<tr>
<td></td>
<td>RESIDUAL</td>
</tr>
<tr>
<td></td>
<td>TOTAL</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>STEP NO. 1 Stepwise Regression Y 1:Att. Comput 4 X variables</th>
<th>Variables in Equation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Variable</td>
</tr>
<tr>
<td></td>
<td>INTERCEPT</td>
</tr>
<tr>
<td></td>
<td>Syllabus Knowl.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Variables Not in Equation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variable</td>
</tr>
<tr>
<td>Gender</td>
</tr>
<tr>
<td>Teaching experi.</td>
</tr>
<tr>
<td>Computer experi.</td>
</tr>
</tbody>
</table>
The result for syllabus knowledge was significant at the 5% significance level. Subjects with current syllabus knowledge had more positive attitudes toward computers than subjects whose syllabus knowledge needed updating. Regression analysis showed that 14% ($R^2 = .141$) of the variation in attitudes to computers could be attributed to this factor.

Regression analysis was used to test relationships between the predictor variable of attitudes to computers with the criterion variables of: beliefs about the program's ability to deliver effective learning experiences, attitudes to interactive multimedia, control of interactive multimedia lessons and teaching strategies selected. The only significant relationship was between attitudes to computers and teaching strategies selected ($F(1, 44) = 9.585, p = .0034$). Analysis of the data in table 4.19 shows that 18% ($R^2 = .179$) of the variation in the teaching strategies selected could be attributed to this factor, and other factors must also be involved, including random variability of responses.
TABLE 4.19  SIMPLE REGRESSION OF THE RELATIONSHIP BETWEEN THE PREDICTOR VARIABLE OF ATTITUDES TOWARD COMPUTERS AND THE CRITERION VARIABLE OF TEACHING STRATEGIES SELECTED

Simple Regression X \( Y \): Att. Comput Y \( Y \): Total.Strat selected

<table>
<thead>
<tr>
<th>Count:</th>
<th>R:</th>
<th>R-squared:</th>
<th>Adj. R-squared:</th>
<th>RMS Residual:</th>
</tr>
</thead>
<tbody>
<tr>
<td>46</td>
<td>.423</td>
<td>.179</td>
<td>.16</td>
<td>1.749</td>
</tr>
</tbody>
</table>

Analysis of Variance Table

<table>
<thead>
<tr>
<th>Source</th>
<th>DF:</th>
<th>Sum Squares:</th>
<th>Mean Square:</th>
<th>F-test:</th>
</tr>
</thead>
<tbody>
<tr>
<td>REGRESSION</td>
<td>1</td>
<td>29.319</td>
<td>29.319</td>
<td>9.585</td>
</tr>
<tr>
<td>RESIDUAL</td>
<td>44</td>
<td>134.594</td>
<td>3.059</td>
<td>p = .0034</td>
</tr>
<tr>
<td>TOTAL</td>
<td>45</td>
<td>163.913</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

No Residual Statistics Computed

Simple Regression X \( X \): Att. Comput Y \( Y \): Total.Strat selected

Beta Coefficient Table

<table>
<thead>
<tr>
<th>Variable:</th>
<th>Coefficient:</th>
<th>Std. Err.:</th>
<th>Std. Coeff.:</th>
<th>t-Value:</th>
<th>Probability:</th>
</tr>
</thead>
<tbody>
<tr>
<td>INTERCEPT</td>
<td>-2.04</td>
<td>.51</td>
<td>.423</td>
<td>3.096</td>
<td>.0034</td>
</tr>
<tr>
<td>SLOPE</td>
<td>.159</td>
<td>.051</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Confidence Intervals Table

<table>
<thead>
<tr>
<th>Variable:</th>
<th>95% Lower:</th>
<th>95% Upper:</th>
<th>90% Lower:</th>
<th>90% Upper:</th>
</tr>
</thead>
<tbody>
<tr>
<td>MEAN (X,Y)</td>
<td>5.437</td>
<td>6.476</td>
<td>5.523</td>
<td>6.39</td>
</tr>
<tr>
<td>SLOPE</td>
<td>.055</td>
<td>.262</td>
<td>.073</td>
<td>.245</td>
</tr>
</tbody>
</table>

Data from observations and search paths

Data from the observations of the individual search paths are included in Appendix 6. The following example demonstrates the analysis of the comments and observations.
Data analysis

All of the transcripts were read and key words and phrases underlined as shown by the example in Table 4.20.

TABLE 4.20 OBSERVATIONS AND COMMENTS - UNDERGRADUATE AND POST-GRADUATE SUBJECTS

<table>
<thead>
<tr>
<th>Subject</th>
<th>Support</th>
<th>Observations and comments during the task</th>
<th>De-briefing comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>B</td>
<td>The navigation map was referred to at the start but it was not used again. Started at the main menu and then read through the lesson plans in sequence. Skipped to the resources sub-menu and commented on the report maker option &quot;This was an interesting option.&quot; Went back to the lessons and then read through further information and the lesson plans. Decided that &quot;Bee Dances&quot; was the most suitable topic. Remembered that he had to select the activities sub-menu in order to teach this topic. Closed booklet and then selected the teaching strategies.</td>
<td>I would like to have been able to interact with the program and test and review the strategies. The lesson plans were the most useful although I could see the value of the resources sub-menu if I had access to the whole package. I found the lesson strategies somewhat limiting but perhaps this is a limit of the package. Time taken = 19 minutes</td>
</tr>
</tbody>
</table>

Each key word or phrase was written on a card and like cards gathered together under categories. Two searching processes emerged: finding information and using information. These were later explored from a cognitive processing framework.

Finding information

To find the information required subjects needed to know what information was available and where it could be found. The navigation
map was designed for this purpose and was used more often by the HyperCard users, but at least five HyperCard users soon realised that they could also refer back to the main menu and use it as a navigation aid instead of the map. Others were content to use a mixture of trial and error with reference to the map when necessary.

Subjects who used the booklet looked at the map at the start of their search but used the map later as a memory-aid to assist them to select teaching strategies. Fifteen read the booklet in sequential order.

No subjects made written selections of teaching strategies as they searched through the support material. It appeared that stopping to make selections would interrupt the information finding process.

Using information

The information in the lesson plans was used most of all because it was familiar and related to the past experience of the subjects. In this section subjects often compared and contrasted options. HyperCard users could use the buttons to do this, and many commented on the novelty value of this option. Also they felt that this was more like a "trial and error" approach. Booklet users had to flip back and forth through the pages to achieve the same goal. Many subjects had narrowed their options down to two or three after exploring the lesson plans. Some branched off along different paths, but the majority referred to the worksheets and information sections in detail. At this stage most subjects had narrowed their choice of topics to one or two possibilities and further exploration at this stage was related to finalising the choice of a topic.
Once a final topic had been chosen, most subjects used the lesson plans and worksheets to provide further information. They then explored the sub-menus that were relevant to the topic chosen.

Some subjects indicated that, at the end of this process, they would have liked to have been linked back to the videodisc player so that they could confirm their selections.

The search paths of subjects were recorded and the following tables of descriptive statistics summarise the information that was obtained from the analysis of these search paths patterns. The results plus data from written observations and comments are discussed on the following pages.

**TABLE 4.21 DESCRIPTIVE STATISTICS FROM THE MAPS OF SEARCH PATHS**

**M1= referrals to lesson plans**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum: 5</td>
<td>Maximum: 17</td>
<td>Range: 12</td>
<td>Sum: 365</td>
<td>Sum of Sqr: 3297</td>
<td>* Missing:</td>
<td></td>
</tr>
</tbody>
</table>

**M2= referrals to information**

<table>
<thead>
<tr>
<th>X2 : M2</th>
<th>Mean: 5.739</th>
<th>Std. Dev: 1.584</th>
<th>Std. Error: 0.234</th>
<th>Variance: 2.508</th>
<th>Coef. Var: 27.595</th>
<th>Count: 46</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum: 3</td>
<td>Maximum: 10</td>
<td>Range: 7</td>
<td>Sum: 264</td>
<td>Sum of Sqr: 1628</td>
<td>* Missing:</td>
<td></td>
</tr>
</tbody>
</table>
M3 = referrals to worksheets

M4 = referrals to main menu

M5 = referrals to overviews

M6 = referrals to database

M7 = referrals to activities
The average number of referrals to the resources and lesson plans, information and worksheets were greater than to the other sections. These sections contained most of the essential information about topics, teaching strategies and the supporting sub-menus of the program. The wide range in the numbers of referrals may be explained by the different cognitive strategies that subjects applied to finding the information needed to: choose a topic, select the required teaching strategies and then link this to the sub-menus from the multimedia program that supported these strategies. To complete this task subjects needed to find and understand how the information could be used to organise effective learning strategies with the interactive multimedia program. Table 4.22 compares the frequency of referrals to the sub-menus on the basis of the support material used and shows that the rank order of the frequencies in each column are similar. In both columns the three most frequently used sub-menus were lesson plans, resources, worksheets, information and the main menu.
TABLE 4.22 MEAN FREQUENCY OF THE NUMBER OF REFERRALS TO SUB-MENUS

<table>
<thead>
<tr>
<th>Sub-menu</th>
<th>Mean referrals by booklet users</th>
<th>Mean referrals by HyperCard users</th>
</tr>
</thead>
<tbody>
<tr>
<td>Database</td>
<td>1.292</td>
<td>2.364</td>
</tr>
<tr>
<td>Activities</td>
<td>1.375</td>
<td>2.318</td>
</tr>
<tr>
<td>Overviews</td>
<td>1.5</td>
<td>2.045</td>
</tr>
<tr>
<td>Worksheets</td>
<td>4.625</td>
<td>5.5</td>
</tr>
<tr>
<td>Information</td>
<td>5.25</td>
<td>6.273</td>
</tr>
<tr>
<td>Main menu</td>
<td>3.375</td>
<td>4.548</td>
</tr>
<tr>
<td>Resources</td>
<td>6.875</td>
<td>8.727</td>
</tr>
<tr>
<td>Lesson plans</td>
<td>6.333</td>
<td>9.682</td>
</tr>
</tbody>
</table>

The starting point of the search paths were then considered and table 4.23 shows where the search paths started.

TABLE 4.23 STARTING POINTS OF THE SEARCH PATHS

<table>
<thead>
<tr>
<th>Started search at:</th>
<th>Booklet</th>
<th>HyperCard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lesson plans</td>
<td>9</td>
<td>12</td>
</tr>
<tr>
<td>Intro./Main menu</td>
<td>15</td>
<td>10</td>
</tr>
<tr>
<td>Other position</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Subjects began their search at the main menu or at the lesson plans and there may be a relationship between these different starting points, and the cognitive strategies used in searching for information. The discussion following describes common features of the search paths and describes the cognitive strategies that may have been employed.
Booklet users

Sequential searchers

Fifteen subjects used the booklet in a sequential manner. They began their search at the start of the booklet (Introduction/Main menu section) and read all pages in sequence. They filled in the table of teaching strategies after they had finished reading the booklet. Eleven of these subjects flipped back to specific lesson plans while filling in their table while another two glanced back at the navigation map. These subjects are described as "sequential" searchers.

Goal-oriented searchers

Seven of the nine subjects who began their search at the lesson plans submenu indicated that they had a topic in mind when they began to use the booklet. Six subjects looked at the contents page and went to the lesson plans and the other three flipped through the booklet until they came to the required page with the lesson plans. Eight of the nine continued to read material related to the lesson plans from the information and worksheets sub-menus before reading other parts of the booklet. Five subjects flipped back and through the booklet to a specific lesson plan when selecting lessons, and three subjects referred back to the navigation map during this process.

The seven subjects who began with a possible topic in mind and appeared to search for information that either confirmed or refuted their initial ideas and comments recorded, supported this interpretation. These seven subjects are described as "goal-oriented" searchers. The other two subjects
also appear to be "goal-oriented" searchers but did not indicate that they had a topic in mind when they began the search.

**HyperCard users**

A single card showing equipment required was used as a starting point. This card contained buttons that could be clicked on to take a subjects to their chosen sub-menu. The first sub-menu chosen was taken as the starting point of the search. Again two common starting points were observed: the main menu and lesson plans. However, the nature of hypertext makes the classification that follows very tentative.

Of the twelve subjects who began their search at the lesson plans, seven looked at the lesson plan cards in sequence but did not do the same for the information and worksheets. They looked at information and worksheets that related to one or two cards only and then returned back to the lesson plan that they had looked at previously. This process was repeated by four of the subjects and this suggests that some subjects had narrowed their topic choices down to one or two options. The observation notes supported this interpretation. After completing this section of the search, they then searched through the other sections of the hypertext material, occasionally revisiting cards to check on information. Five of these subjects referred back to the navigation map when they went to a new sub-menu, and six referred back to the map near the end of the search to check that they had completed the search. Subjects referred back to the lessons plans as they filled in their planning table.

The four subjects who did not follow this pattern made a more random search of the cards. They randomly clicked on buttons on the cards and
didn't seem to follow a goal-oriented search pattern. Comments such as "I am just exploring the cards to see what's here" support this interpretation. Two of these subjects glanced at the navigation map at the start of the search but did not use the map again. Subjects referred back to the lesson plans as they filled in the selection table.

There appears to be two types of approaches taken: one group of subjects had a topic in mind and followed a search plan to confirm or refute the topic choice. These subjects appear to be similar to the "goal-oriented" searchers with the booklet. But there were others who did not follow any pattern and began by randomly searching through the cards.

Of the ten subjects who started their search at the main menu, four then went to the lesson plans and scrolled through the lessons available, and then proceeded to follow a search path similar to "goal-oriented" searchers mentioned above. Five others appeared to use the main menu as a navigation aid. They clicked on a button and read through a set of cards related to the button before returning to the main menu. Each time they returned to the main menu they would then choose a different button and repeat the procedure. These subjects did not refer back to the navigation map until the end of their search; instead they appeared to use the main menu as a navigation aid. These are described as "on-screen navigators". The sixth subject who started at the main menu, used a pen to mark out a navigation path for himself on the map. He followed this path which explored all sections. All subjects filled in the table of teaching strategies at the end of their search and again most subjects navigated back to a lesson plan card.
The cognitive strategy that appeared to be common to both the hypertext and printed text materials was described as a "goal-oriented" strategy. Subjects who adopted this strategy decided upon a topic beforehand and were searching the support material to confirm or refute the topic chosen. They were also searching for ways of applying the program to support the topic. Therefore they appeared to search for information that was relevant to their goals.

The "sequential" searchers were from the group who used the booklet. It needs to be stated that some of the "sequential" searchers could have also been "goal-oriented" and even though evidence from written observations did not support this view, this interpretation needs to be treated with some caution. This cognitive strategy employed by the "sequential" searchers was typically associated with some, but not all, users of printed text. An equivalent group of "sequential" searchers was not observed with the hypertext support because the hypertext is non-linear, and sequential searches have no real meaning in such an environment. Some subjects may have tried to search in sequential mode at the start but gave up this strategy when they found that it didn't work. Some of the subjects who searched in sequence through the lesson plans, information and worksheets cards may have belonged to this "sequential" group if they were using printed text. The search strategies of these subjects may have become random as they became less decisive about their search path in the hypertext environment.

The subjects who were the "on-screen navigators" in the hypertext environment relied upon the main menu for a navigation and written observations supported this interpretation. But, closer examination of the
data showed that the navigation map was used on at least two occasions by all subjects. Therefore the navigation map also appeared to assist in navigation. This group of subjects also appears to include some who were making less purposive searches. Also the data showed that some, but not all, of these subjects made more interactions or movements around the cards. Therefore the "on-screen navigators" group may actually consist of other sub-categories which were not able to be identified. This aspect of the study needs further investigation.

**Maps of search paths**

The maps that follow show examples of the search paths followed by subjects as they used the support materials. An asterisk marks the starting point and the word "end" marks the end point. The numbers refer to the names of the topics listed in the key in the lower left-hand corner. The main paths are shown. Some recursive movements are missing off maps because they could not be drawn but descriptions indicate where these occurred.

Map 1 is an example of a search path that shows a great deal of interaction. The subject began her search at the "Main Menu", she then went to "Overviews", followed by "Getting Started" and then back to the "Main Menu". This section appeared to be used as a navigation aid and was frequently referred to. The "Database" and "Activities" sub-menus were explored before she went to the "Lesson Plans" where she scrolled back and forth through lessons 1 to 3. At this stage she stated that she began with an idea for a topic and was comparing the topic of the "Turtle Mystery" (topic 4) with other possibilities. She then went back to lesson 1 and then to the information on lesson 1. After she went to the "Resources"
sub-menu but changed her mind and went back to "Lesson Plans" to look at lesson 4. From here she went to the "Worksheets" section and looked at the worksheets for lessons 1, 2, 3 and 4. Then she went back to read the information about lesson 3. From here she went to the "Resources" sub-menu and looked at the "Report Maker" and the "Videodisc Controller". She went back to the "Resources" sub-menu and then looked at the "Navigator" and the "Navigator screen". At this stage she went via "Help" and "Resources" to the lesson plan about the "Turtle Mystery" and chose the "Turtle Mystery" topic. After she explored the "Navigator" and "Activities" sub-menus she returned to the "Main Menu". Finally, she went back to the "Database" to check on what this sub-menu contained. The subject stated that her normal work practice was to search out alternatives before making decisions, but she was convinced from the start that the "Turtle Mystery" would generate a great deal of interest and excitement in children. She took time to look at other possibilities because she thought that she should at least check to see if an even better option was available.
Map 1: Search pattern for undergraduate 202 using HyperCard support.
Time for task = 20 minutes.

Map 2 is an example of the search path taken by a subject who was experienced with HyperCard. He started at the lesson plans and scrolled topic 1 to 5 and then went back to topic 1. At this stage he indicated that he would most likely select this topic. He then checked the information and worksheets about all topics and moved back and forth comparing each card. He then went to the main menu and realised that this could be used as a navigation aid. His search path covered all other aspects of the
sub-menus with frequent referrals back to the main menu for navigation purposes.

Map 2: Search pattern for undergraduate 219 using HyperCard support.
Time for task = 17.5 minutes.

Key
1 Beaver Pond
2 Animal Migration
3 Protective Colouration
4 Turtle Mystery
5 Bee Dances

- main menu
- secondary menu
Map 3 is of a female undergraduate using a booklet. Her search pattern is much shorter because she had decided upon a topic after comparing the lesson plans, but the time taken was 14 minutes because there were frequent pauses as she thought about which options were the most useful. She very carefully read the options associated with the topic of her choice, but ignored options that were not relevant to her topic. This aspect is clearly illustrated in the resources section of her search path where she only explored the sections relating to the video editor and report maker options. The decisions made previously about the topic and strategies appear to have limited the search path and may have limited the teaching strategies selected.
Map 4 is of a male undergraduate who took little time and did not explore all sections of the booklet. Again this subject started by comparing the lesson plans and then confirmed his choice when he read the information and worksheet sections. However, he only glanced over the database and activities sub-menus and these sub-menus were applicable to the topic chosen. Because he did not read these sub-menus properly, he failed to link these sub-menus to the teaching strategies chosen. The path is
atypical, but is included to illustrate how a poor search can lead to unproductive planning of learning experiences. The topic chosen was "Animal Migration". This topic encourages self-exploration, problem solving and multimedia publishing but the subject has to know which sub-menus of the program support these activities. This subject would need to explore the database sub-menu (self-exploration), the activities and database sub-menus (problem-solving) and the resources sub-menu (multimedia publishing).
Map 4: Search pattern for male undergraduate 226 using a booklet.
Time for task= 11 minutes.

Worksheets

Lesson plans

Equipment

Getting started

Main menu

Overviews

Database

Activities

Resources

Help

Navigator

Video editor

References

Report Maker

Videodisc controller

Key
1 Beaver Pond
2 Animal Migration
3 Protective Colouration
4 Turtle Mystery
5 Bee Dances

main menu

secondary menu
Summary

This study examined a planning process teachers used to select teaching strategies that they would use with the "Animal Pathfinders" interactive multimedia program. This process used support material that was in HyperCard and in booklet form. The effects that the two forms of support material had upon the final strategies selected by subjects was evaluated, and it was found that subjects who used the HyperCard support materials chose a greater variety of teaching strategies (but it needs to be kept in mind that these are intentions and not deeds). They were also more likely to link the supporting sub-menus of the "Animal Pathfinders" program to their chosen teaching strategies. Caution needs to be attached to this finding as there were other factors that could have led to this result.

Of the twenty one hypotheses tested, seven were found to be significant at the 5% level of significance. These hypotheses related to the support material used, the amount of control teachers permitted, the teaching strategies chosen and the effects of additional time. The main findings are discussed under the headings of: support material, navigation, cognitive strategies, teaching strategies, and teacher attitudes.

Support material

There was no significant difference between the ratings of the different forms of support, but inexperienced teachers gave higher ratings to the all forms of support than experienced teachers. Females also rated the support material more highly than the males.
Responses from subjects in post-session interviews suggest that the HyperCard support was easy to use and acted as a positive reinforcement for those who were inexperienced computer users. They also commented on how the buttons associated with the HyperCard stack allowed them to move backwards and forwards through the information. The novelty of this material, coupled with a desire to explore may be reasons why they took longer to complete their planning task than the booklet users. Another reason may have been associated with the additional time needed to navigate through the hypertext, and to gain a "feel" for the range of information available.

The teaching strategies chosen by the HyperCard users were more varied and made greater use of the sub-menus that supported strategies associated with small group learning and individualised instruction. HyperCard users were presented with single on-screen cards that contained buttons that could be used to link to other cards. This arrangement of information may have helped HyperCard users to organise information into clusters of related ideas or "chunks" (Yates and Moursund, 1989); but it needs to be recognised that this effect may also be associated with the extra time taken by the HyperCard users.

Nine subjects who were given extra time selected a similar variety of teaching strategies to other subjects, but the individual strategies selected involved small group work and individualised learning. All of these subjects showed that they could correctly identify the sub-menus that supported these teaching strategies. Therefore the additional time may have helped subjects to recognise which teaching strategies were most appropriate.
Navigation

The subjects who used the HyperCard support developed by the author made greater use of the navigation map, but some learnt to navigate by referring back to the main menu card. Many booklet users navigated through the material in a linear sequence and made little reference to the navigation map. It appears that the effects of "cognitive overload" due to navigation had been minimised, but not completely overcome, by keeping the planning information on each card to the essentials required and limiting the number of cards in the HyperCard stack.

Cognitive strategies

Analysis of data obtained from maps of search paths made it possible to describe and tentatively classify the cognitive strategies used.

The cognitive strategy of "goal-oriented" searching was applied to both forms of support but "sequential" searching strategies used with printed text appeared to break down when applied in the hypertext environment and this may have forced hypertext users to adopt a cognitive strategy that made greater use of the navigation aids available.

Teaching strategies

Post-treatment interviews with inexperienced teachers showed that they were selecting strategies that they were "comfortable with". Similar comments were made during a debriefing session with experienced teachers and typical comment from an experienced teacher was "it will take me some time to learn to use this new equipment properly without
the extra burden of trying out teaching methods that I rarely use." These
comments support the findings that teachers who initially use interactive
multimedia are likely to use teacher centred strategies because they feel
more confident with this style of teaching.

Teacher attitudes

Subjects with current syllabus knowledge had more positive attitudes
towards computers and this could be related to the superior knowledge
that these subjects had about the application of computers to the
syllabuses they taught. Inexperienced computer users felt comfortable
with HyperCard support material and this finding suggests that positive
reinforcement in the initial training may overcome past negative attitudes.

The training of teachers will need to address these factors and the
proposition that it is no longer good enough to provide a simple
instruction manual. The teacher support materials of interactive
multimedia programs must show that the program can be easily and
effectively used in the classroom, otherwise it may lie gathering dust like
many past examples of educational technology.

This study has shown that the form of support material provided to
teachers will be a factor in determining the choice of instructional strategy
with interactive multimedia. The experiences that teachers have with this
support material can influence their attitudes so that they are more likely
to take full advantage of what interactive multimedia programs have to
offer.
It has also shown that teachers will need to re-examine the teaching strategies they use, and that additional emphasis on pupil-centred teaching strategies in pre-service and inservice training may be necessary. These issues and other relating to the research will be discussed in more detail in the next chapter.
CHAPTER 5 CONCLUSION

This chapter begins by discussing the relationship between the results and the major research questions. It also discusses how the outcomes of this research may be related to the training of teachers in the use of interactive multimedia and makes recommendations for further investigation.

How the findings relate to the research questions

Each of the research questions raised are discussed with respect to the findings.

1. What identifiable strategies did the teachers employ in working through the interactive multimedia support materials? What search paths did they take?

Caution needs to be exercised in interpreting these findings because a certain amount of overlap between categories may be possible. While the generalisations that follow are tentative, they serve to identify an aspect of this study that warrants further investigation.

Two cognitive strategies that could be applied to both forms of support material were described as "goal-oriented" and "sequential" strategies. The "sequential" strategy appeared to break down in the hypertext environment and subjects had to then resort to another strategy. This did not appear to be the case with the "goal-oriented" strategy.
Some subjects attempted to apply cognitive strategies that had been successful with printed, sequential text to the hypertext learning environment, and these may not have been appropriate. Different cognitive strategies may be needed to take full advantage of the non-sequential nature of hypertext, and the use of navigation aids may be an example of an attempt to do this.

The "sequential" search paths followed a linear path through the information. In the booklet such a path followed the information in the order it was presented, and in the case of hypertext, the order often followed the presentation sequence of the cards grouped about a specific feature. For example, many sequential searchers of hypertext followed the lesson plan and information cards in sequential order. Sequential searchers of the booklet often followed the sequence of the printed pages, but the hypertext users could not do this and instead could create their own sequence.

"Goal oriented" search paths could be limiting for some booklet and hypertext users, if they didn't read all of the required information. This could lead to inappropriate use of the interactive multimedia program.

Some of the "internal navigators" of the hypertext used the main menu as a navigation aid. This group had search paths that showed frequent referrals back to the main menu. By contrast, the booklet users who may have been "internal navigators" followed strategies such as using the contents and flipping through pages to sections of specific interest. However, the search paths of these subjects showed few referrals back to the contents.
2. Did the three phase training process assist teachers to plan effective teaching strategies with interactive multimedia?

The answer to this question is a modified yes, but the timing of the phases involved in this process is very important.

The training process used in this study involved three phases that were modifications of those suggested by Havelock (1982). The first phase was a 30 minute introduction to the technology and the interactive multimedia package, demonstrating how it can be used with children. The introduction phase was used because it could help alleviate some of the initial fears that subjects might have towards the technology. It also provided an overview of the main features of the program.

Early trials with the presentation quickly showed that information overload was a major problem to be overcome. The findings from these trial studies showed that novice users needed to know how to get started, what they could do with the program and what to do if they were lost. Therefore the 30 minute introduction concentrated on these aspects and was designed to be a non-threatening, positive experience.

Comments made by most subjects during interviews indicated that they would have liked to have seen a video of a group of children using the interactive multimedia package. The original demonstration could be refined and presented with the inclusion of a short video before the free exploration step. A video tape presentation could be taken away and viewed again at a more convenient time and place. This issue could be followed up with a
study of the effects upon the ways teachers use the program after viewing a video presentation that models the various teaching strategies that are applicable.

Research by Barker (1989) has provided some insight in the use of instruction with interactive multimedia. The findings showed that some interactive multimedia packages do include instructional video tapes but their effectiveness was questioned because of the lack of systematic trials and the minimal contribution by practising teachers.

The second phase in the instructional process was a period of free trial where pairs of subjects could work together to trial aspects of the package demonstrated in the previous phase. The grouping of subjects into supportive pairs for this step appeared to be an effective way of reducing anxiety. No quantitative data was collected during this phase but subjects commented that this step was enjoyable because they were free to follow their own interests.

During the third phase, which involved application and integration, subjects were required to complete a specified instructional planning task that would make use of the interactive multimedia program.

This phase was designed to simulate a typical planning task that teachers might undertake before they use the program. This task demanded more of the subjects because they had to process and apply information about the technology. Most subjects took between 12 and 25 minutes to complete the planning task with most time spent exploring the support materials. This phase forced subjects to think about how to use the technology in the context of their teaching situation.
The general findings from the three phases that have implications for training teachers in the effective use of interactive multimedia are:

- the introductory phase could be supported by a video tape but this will increase production costs of the whole package. The alternative is to develop an instruction package that has a general application. This could be in the form of interactive multimedia or video.

- comments by subjects suggest that the trial phase is effective and enjoyable because subjects worked in supportive pairs, but this mode may not suit all.

- the whole process is likely to be effective when there is a clearly defined purpose, and an example is the third phase in this process.

3. Did the use of different forms of teacher support material lead to differences in planning outcomes and attitudes toward the technology?

Yes, differences did occur in the planned teaching strategies and the attitudes they had toward the technology.

*Planned teaching strategies*

The teaching strategies chosen by the users of the HyperCard support were more varied and supported strategies associated with group learning and individualised instruction, but other factors, mentioned previously, may have been involved. Follow up research is needed as this effect may have been due to the effect of "chunking" (Yates and Moursund, 1989) associated with the differences in the
way that data was presented in the hypertext environment and how subjects were able to make cognitive links between this data and the deep structure of the interactive multimedia program that they had used. This effect may also be associated with the additional time taken by the HyperCard users.

*Attitudes towards the technology*

Most subjects scored low on the risk-taking questionnaire and this may be a factor that restricts the learning strategies chosen to those that are teacher-centred. For example, teachers who are not confident with new technology may be unwilling to take risks, and are likely to choose low-risk learning strategies that are teacher-centred. Such a reluctance to change teaching methods to accommodate computers in the classroom has been identified in past by Offir and Katz (1990).

The findings also showed that teacher attitudes to computers was a factor and subjects with positive attitudes toward computers tended to choose teaching strategies that were learner-centred.

The following factors may have affected teachers attitudes toward the use interactive multimedia in the classroom:

- the interactive multimedia program was easy to use and comments by subjects focussed upon the following features: all you to do was click on an icon and generally what was expected would happen, if a mistake was made you could go back, the screen told you what to do.

- the effects of experiences that they had with the program.

- the quality of the support material.
• the effects of previous experience with computers.
• current syllabus knowledge, and teaching experience.

Many teachers commented that the program was fun to use and would appeal to children, but this alone did not convince them of its effectiveness in a school situation. Inexperienced teachers were uncertain about the educational value of the program, and more time or further teaching experience may have been needed to convince them of its value.

There may be a need to provide inexperienced teachers with further experience with educational technology during their pre-service training. In particular, pre-service teachers need classroom experience involving the use of interactive multimedia with children. All of the pre-service teachers interviewed indicated that they had not used computers with children in a classroom. By comparison, most of the experienced teachers interviewed indicated that they had used a computer with a group of children in a classroom even though it may have been at a very superficial level such as playing computer games.

Pre-service courses in teacher education provide experience with educational technology, but the skills developed in these courses need to be applied in the classroom. Few teacher education courses require trainee teachers to teach with computers and this may be a weakness with current courses.

The findings showed that inexperienced computer users benefited from the positive experience with the HyperCard help stack and this experience positively reinforced their attitudes towards the interactive multimedia program.
There has been a greater emphasis on educational technology and student-centred learning strategies in new syllabuses (Board of Studies, 1989). Teachers who have been motivated to learn about the new syllabuses and apply them to their teaching context would be aware of this. This may explain why teachers with current syllabus knowledge had more positive attitudes towards computers and had a tendency to select a greater variety of teaching strategies.

This aspect of the study requires further investigation to determine if teachers with current syllabus knowledge are those that want to learn more about their subjects as these teachers may have greater motivation toward learning new skills than their colleagues.

It is important that the design of support material used with interactive multimedia provide positive learning experiences for teachers of all levels of ability. Instructional designers will have to make a much greater effort to achieve this goal and more extensive research into the design of instructional support material is needed.

The hypertext support did provide positive reinforcement to teachers who were inexperienced with computers and this finding supports the research of Summers (1990) who showed that negative feelings of teachers about computer based technology can be altered through recent positive experiences.

The positive effect of the HyperCard support with inexperienced teachers appears to related to its simple design. Appendix 5 shows a printed version of each card. It can be seen that the information presented was brief but relevant and the design of buttons and navigation cues consistent. A simple, electronic form of
teacher support that can encourage teachers to feel more positive about the technology is of value. Such a form of support also acts as an advanced organiser by raising the cognitive expectations of the users. The form of this support can be based upon platforms other than HyperCard, but if an electronic form of support is going to have a desired effect, then the principles that support human interface guidelines (Apple, 1987) would apply.

4. What was the effect of the advanced organisers upon the training process and its outcomes?

The advanced organisers were designed to help subjects to understand the structure of the instructional material provided and the purpose of the planning task. The planning table filled in by subjects appeared to have two effects. It provided a graphic outline of the outcomes expected, and at the end of the search process may have assisted in the organisation of the knowledge acquired.

The navigation map appeared to assist inexperienced computer users to navigate through the HyperCard help stack, and the findings show that it was used more frequently by subjects who used the HyperCard help stack. The design of the stack did allow users to navigate via the main menu card and some subjects took this option instead of using the navigation map. The map was also used as an aide memoir to help in the task of selecting teaching strategies.

5. Did the time spent with the instructional material affect teaching strategies selected?

The findings show that the subjects who use the HyperCard help stack took longer to complete their search and had a greater number
of interactions between the main sections of the support material, and the teaching strategies they selected were more likely to focus on individual and small group work. This additional time may have been used to discover the full range of options available.

Findings from a pilot study with six volunteers showed that the factor of time made little difference without some form of initial instruction. During the main study, all of the nine subjects who were given extra time with the program expressed confidence about teaching with interactive multimedia. Also they developed lessons that employed learner-centred teaching strategies. The sample was very small but the findings do suggest that the provision of additional time after the initial training was of benefit.

6. What type and variety of teaching strategies do teachers employ when they begin using this technology? What are the consequences of these choices?

The findings show that teachers do choose a limited range of teaching strategies when they begin using this technology and this supports the findings of Hawkins and Sheingold, (1987). The consequences of these choices are likely to limit the effectiveness of interactive multimedia as a means of instruction because most teachers selected teacher-centred learning strategies.

Interactive multimedia programs may be based upon instructional models that make use of organisation that allows for individual and group learning that encourages self-exploration and peer collaboration, but there is a tendency for teachers to select teaching
strategies that do not support these ways of learning. To be effective, with this form of interactive multimedia program teachers will have to broaden their teaching skills Litchfield (1990).

Often teachers are reluctant to use learner-centred strategies with classes because there is a greater risk factor involved with the more complex organisation required. In particular, teachers are even more reluctant to use learner-centred strategies with new technology like interactive multimedia; but effective use of this technology in the classroom requires teachers to expand their teaching skills and employ strategies that are different to those traditionally employed in their day to day teaching.

Teachers have to adopt learner-centred strategies and this change of focus will require them to develop new skills in themselves and in their pupils (Litchfield, 1990). Learners will have to be shown how to employ skills that allow them to work individually, in pairs, and in small groups in a learning environment that encourages cooperative work and collaboration. Many teachers have not been trained in methods that develop these skills and will require inservice support. The following quote from a case study by Briscoe (1991: 189) illustrates the problem:

...Brad believed that students should take more responsibility for their learning... (but) because Brad viewed his role as a teacher as a performer and a giver of knowledge, he was unable to function in the cooperative learning model which requires students to take responsibility for their own learning. The conflicts Brad experienced in practice because of his beliefs about how children learn and his role of facilitating learning prevented him from making lasting changes.
Concluding remarks

The training of teachers in effective teaching with interactive multimedia technology will require more than instruction in the use of the technology. It also requires that teachers re-examine their attitudes and beliefs about teaching and base their teaching upon a new paradigm constructed from this process. Such a change is threatening and challenges attitudes and beliefs that many teachers cherish.

Well designed software and teacher support can assist in this process of change which will take time. It requires instructional designers to consider the training of teachers as part of their total package. It is not good enough to design an interactive multimedia program that does not provide quality teacher support.

The findings from this study suggest that the following factors need to be considered when designing teacher support.

1. The effect that the structure of the support material can have upon the cognitive strategies applied by the user.
2. The need for different forms of advanced organisers to assist in navigation, cognitive processing and planning
3. The positive reinforcement associated with the support material can help to change negative attitudes toward the technology.

The findings also suggest that those involved in training teachers in the use of interactive multimedia need to consider the following:

1. The attitudes that teachers have toward new instructional technology can restrict the way they teach with interactive multimedia.
Therefore, even if instruction is well designed and structured, some teachers will still use inefficient teaching strategies with new technology.

2. The second phase of trial and exploration needs flexible organisation in terms of time and grouping of teachers. Many (but not all) teachers will want to work in pairs that can provide mutual support for each other; while others will require more time to internalise and apply new knowledge.

3. Preservice teachers need classroom teaching experience with interactive multimedia.

Although hardware and software can provide valuable assistance, teachers have to be motivated to effectively use the material on offer. This requires a commitment by teachers and administrators to the training process. Just providing the hardware and software alone is not good enough. Teachers and schools must be prepared to make a real commitment in terms of time and effort. This will enable them to learn new skills and re-examine and modify past practices that will make it possible for interactive multimedia to become an effective way of delivering educational experiences in schools.

**Recommendations for further research**

1. Teachers find it difficult to change from a teacher-centred to a pupil-centred approach to learning (Marshall, 1990: 131). This task becomes even more difficult when they also have to deal with new technology. We need to understand the reason why they are so reluctant to change and to identify factors that will encourage the processes of change to occur.
2. A process that involves a number of phases is needed to introduce the technology and research is needed to find out if:

- there is an "ideal" process that can act as a model for training applications associated with interactive multimedia and the work of researchers in the field of innovation in education may provide further insights into this process.

- there is a time interval that is applicable to each phase. For example it may be inappropriate to extend the introductory phase beyond forty minutes but the trial phase may extend for periods of up to ninety minutes.

4. We have to view this problem of training information technology from the perspectives of the teachers. Therefore research is needed into professional development programs in information technology that support the needs of the organisation, as well as the teachers' needs for professional development and career development.

Questions about control, access to technology and of power arise and have a strong positive and negative influence over teacher attitudes toward information technology.

5. The organisation of hypertext information makes new demands upon established cognitive strategies of learners. Further research is needed to clarify the nature of these demands and to suggest ways of supporting learners to modify these strategies so that they can be more efficient in the use of hypertext.
BIBLIOGRAPHY


APPENDICES
### Appendices

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<td>A5</td>
</tr>
<tr>
<td>6.</td>
<td>Data from comment and observations</td>
<td>A6</td>
</tr>
<tr>
<td>7.</td>
<td>Lesson plans from subjects given extra time</td>
<td>A7</td>
</tr>
<tr>
<td>8.</td>
<td>Comments from follow up interviews</td>
<td>A8</td>
</tr>
<tr>
<td>9.</td>
<td>Numerical data</td>
<td>A9</td>
</tr>
</tbody>
</table>
Appendix 1

Data from the pilot study
**APPENDIX 1 : DATA FROM THE PILOT STUDIES CONDUCTED IN 1991**

**Question 1**

*Do you think that interactive multimedia is easy to use? What is the reason for your response*

<table>
<thead>
<tr>
<th>Option</th>
<th>Reason</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>it tells you what to do.</td>
</tr>
<tr>
<td>No</td>
<td>technical problems.</td>
</tr>
<tr>
<td>Yes</td>
<td>instructions easy to use.</td>
</tr>
<tr>
<td>Yes</td>
<td>motivating, lots of fun.</td>
</tr>
<tr>
<td>Practice needed</td>
<td>difficulties at first.</td>
</tr>
<tr>
<td>Yes</td>
<td>the computer tells you what to do.</td>
</tr>
<tr>
<td>Yes</td>
<td>the computer gave instructions.</td>
</tr>
<tr>
<td>No</td>
<td>difficulty accessing the program required.</td>
</tr>
<tr>
<td>No</td>
<td>not easy without knowledge of computers and multimedia products.</td>
</tr>
<tr>
<td>No</td>
<td>phobia and dislike of computers.</td>
</tr>
<tr>
<td>Yes (3)</td>
<td>self explanatory, easy to operate and understand.</td>
</tr>
<tr>
<td>Yes</td>
<td>any difficulties can be overcome with continued use.</td>
</tr>
<tr>
<td>Yes</td>
<td>with time to know how to use it.</td>
</tr>
<tr>
<td>Yes</td>
<td>training, experience, teacher support.</td>
</tr>
<tr>
<td>Yes</td>
<td>easy if you know how to use a computer.</td>
</tr>
<tr>
<td>Uncertain</td>
<td>as one has to be aware of the technology.</td>
</tr>
<tr>
<td>Yes</td>
<td>if computer technology, user friendly.</td>
</tr>
<tr>
<td>Yes</td>
<td>if you are computer literate.</td>
</tr>
</tbody>
</table>

**Comments**

This initial experience convinced me that any worthwhile research would require an IM package that was "user friendly". After trialing other packages I decided to use "Animal Pathfinders" because it was the least threatening to inexperienced computer users.
Question 2

Where do you think that interactive multimedia be located in schools? Why?

Computers rooms
library/sound proof room
library
special room
computer room or classroom
central position
classrooms/libraries
special room/sound proof
library/computer room
room off library
in classrooms if possible
separate rooms off classrooms.
general purpose area/ library computer
room,
in classrooms
in a laboratory of IM units

Comments

The issue of who should be responsible for such equipment was raised by many respondents.

Question 3

How would you organise a typical year 5 or 6 class to use interactive multimedia?

groups, everyone doing the same options
integration with other curriculum areas.
small group work.
as part of an overall unit, many ways.
within a unit of work.
as a total program, small group work or whole class activities.
integration with environmental education, social studies, natural science.
as an information source to encourage deeper thought.
a specific unit, integration of IM into the class.
I may get bored.
if it fitted in with what I was doing, groups
can be used in all different subjects in many different ways.
with restraint.
to deconstruct the text- what are the value inherent in the video?
to allow students to discover
Comments
Most prefer to use the IM package to supplement a class unit. The limited range of responses may be due to:
• the fact that some subjects were not given an orientation lesson before using the equipment
• a lack of time to "explore" the system.
• subjects did not fully understand the possibilities of the system.
• attitudes of subjects toward computers.
These issues need to be addressed during the study.
Question 4

List some problems (other than cost) that may occur with the use of interactive multimedia.

I'd have to use it! a distraction, children asking me for help.

timetabling all students to have turns.

whole class use.

distracting for other class members.

space.

lack of time for all students to use IM.

children not computer literate.

space, privacy, distraction.

technical problems.

management - access.

getting all students involved.

keeping class on task.

prior training of teachers.

not paying attention..

unable to use equipment.

student damage.

confidence to use computers.

structured, standardised form of knowledge.

not knowing how to make the most of it.
Comments

Subjects expressed concerns about issues of: access, space, time, distraction and confidence associate with the use of IM.

**Additional comments by trainee teachers:**

- looks scary - what if I can't follow the directions!
- I was impressed, amazing.
- stunned to see how far technology has progressed.
- great teaching resource.
- frightening - computers worry me.
- could be useful - need more education in its use.
- difficult to use unless computer literate.
- some parts boring.
- dependency on the computer for learning.
- too guided
- need individualised instruction in order to feel comfortable with the technology.
- fairly daunting.
- standardising of the material to be learnt.

Comments

Again the issue of the subjects' expressed attitude toward computers relates how the package is perceived. The final group also expressed concerns about the standardising of the material presented in the package.
Discussion

The trainee teachers expressed concerns about:

• confidence with technology and

• the degree of learner control versus teacher control.

The concerns with confidence may be related, in part, to the attitude that each has toward computers. Observations showed that those who were less confident limited their interaction with the computer system to the lowest level of use and tended to only use the video control features. That is, they were using the system as a substitute remote control for the video disc. They avoided the other, less familiar features such as the data base, interactive research and report maker.

Comments made by trainee teachers about student calls for assistance could mean that some fear that their students will become more proficient than they are and this could lead to feelings of inadequacy. Such feelings may be revealed indirectly by the ways that trainee teachers intend to allow students to use "Animal Pathfinders". The concern over control may be related to confidence and risk taking attitudes. As a result trainee teachers may prefer to restrict students to sections of the package that they are familiar with.; or those who encourage risk taking with their pupils may place less restrictions upon student use of interactive multimedia.

Other concerns over control relate to the subject matter presented, access and classroom use. The concerns expressed about the standardisation of subject matter reveal a lack of understanding of way the interactive multimedia package can be used.

Concerns were raised about how accessible this technology will be to them as teachers and the students in their care. Other related concerns were:
• the power interactive multimedia to gain student attention, and distract them from other classroom activities. That is, some of the control in the classroom will shift from the teacher and to the student.

• the need to organise school procedures about location, access and responsibility for interactive multimedia.
Appendix 2

The questionnaires
APPENDIX 2.

PRE-TREATMENT QUESTIONNAIRE 1992

Instructions:
Please write the number assigned in the space provided. You will need to remember this number as you will need to write it on your second questionnaire. Please be frank with your answers to the questions as there are no "right" or "wrong" answers.

Thank you for your co-operation,
Brian Ferry

1. Please enter your allocated number ................................

2. Gender (circle) Male Female

3. The number of years that I have been teaching is ......................years.

4. Please circle the label that you feel describes your computing experience.
   
   Inexperienced I am a novice with computers.

   Experienced I use a computer on a regular basis to prepare lessons and record marks, and can confidently use word processing and drawing programs.

5. Please circle the label that you feel describes your knowledge of the syllabuses that you teach.
   
   adequate I am familiar with the syllabuses I teach but I am not up to date with all of the latest ideas associated with teaching these syllabuses.

   current I am confident that I fully understand the syllabuses I teach and I am up to date with the latest ideas associated with teaching the syllabuses.
Respond to each question, by placing a cross in the space that indicates how you prefer to teach students in your class. If you are a secondary teacher, choose a class between years 7 and 10 that you feel reflects the way you usually teach.

More than 75% of times
Between 50% and 75% of times
Between 25% and 50% of times.
Less than 25% of times.
Never

<table>
<thead>
<tr>
<th></th>
<th>more than 75% of times</th>
<th>50-75% of times</th>
<th>25-50% of times</th>
<th>less than 25% of times</th>
<th>Never</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>I use small group cooperative learning with my class.</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>7</td>
<td>I allow students to choose the members of their groups.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>I choose the learning task for students.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>I organise students to work on the same task at the same time.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>I permit students to use equipment such as computers and video cameras.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>I encourage student discussion.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>I use video presentations with my classes.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>I permit students to move about to discuss their work and to help each other.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>I use whole class lecture/demonstration teaching methods with my classes.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>I like to vary student activities during lessons.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>I allow students to work individually or in pairs on &quot;hands on&quot; activities.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>I try out new ideas with my students.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>I like to keep children &quot;on task&quot;.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>I allow my class make decisions about classroom activities.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>I prefer to have students working quietly.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>21. I am confident when I use audio visual equipment with my classes</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

22 I have previously used interactive multimedia. Yes/No.
RISK-TAKING QUESTIONNAIRE
Place a cross in the appropriate box to indicate your rating of the risk associated with the statements listed below.

<table>
<thead>
<tr>
<th>Low risk</th>
<th>Mod low risk</th>
<th>Medi -um risk</th>
<th>Mod. high risk</th>
<th>High risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>23. Leave your job before finding another one.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>24. Study a profession in which it is difficult to get a job.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>25. Invest all your savings in a high-risk, high-profit business.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>26. Complain to your principal about your direct supervisor.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>27. Teach at a new and unrecognized school because of its attractive and unorthodox curriculum.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>28. Buy a used car without getting it inspected by a competent mechanic.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>29. Change your occupation at middle age out of free will.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30. Transfer to a new school without knowing what it was like to work there.</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>31. Sell your home before buying or renting a new home.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>32. Undertake a new high-income job without having the necessary professional qualifications to ensure success.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
ATTITUDES TO COMPUTERS.

Place a cross in the appropriate box to indicate your response to the statements about computers listed below.

<table>
<thead>
<tr>
<th></th>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Undecided</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>33.</td>
<td>It is easy to get tired of using a computer.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>34.</td>
<td>People who use computers in their jobs are the only people who need to study about computers.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>35.</td>
<td>Learning about computers is interesting.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>36.</td>
<td>School would be a better place without computers.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>37.</td>
<td>I enjoy using a computer.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>38.</td>
<td>Computers are boring.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>39.</td>
<td>Working on a computer is a good way to spend spare time.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>40.</td>
<td>Computers help people to think.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>41.</td>
<td>Reading and talking about how computer might be used in the future is boring.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>42.</td>
<td>Learning to program a computer is something I can do without.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>43.</td>
<td>Learning about computer hardware and software is fun.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>44.</td>
<td>I enjoy learning about how computers are used in our daily lives.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>45.</td>
<td>Studying about the uses and misuse of computers is useful.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>46.</td>
<td>I wish I had more time to use computers in school.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
TEACHING METHODS AND INTERACTIVE MULTIMEDIA

Respond to each question by placing a cross in the space that indicates how you would prefer to teach students in your class with interactive multimedia. The categories are:

More then 75% of times  
Between 50% and 75% of times  
Between 25 and 50% of times  
Less than 25% of times  
Never

<table>
<thead>
<tr>
<th>Question</th>
<th>more than 75% of times</th>
<th>50-75% of times</th>
<th>25-50% of times</th>
<th>less than 25% of times</th>
<th>Never</th>
</tr>
</thead>
<tbody>
<tr>
<td>I use small group cooperative learning with my class.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I allow students to choose the members of their groups.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I choose the learning task for students.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I organise students to work on the same task at the same time.</td>
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<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>I encourage student discussion.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I permit students to move about to discuss their work and to help each other.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I use whole class lecture/demonstration teaching methods with my classes.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I use whole class guided discovery teaching methods with my classes.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I allow students to work individually or in pairs on &quot;hands on&quot; activities.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I like to keep children &quot;on task&quot;.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I like to vary student activities during lessons.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I allow students to work on independent research.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I would allow students to create their own multimedia reports.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I try out new ideas with my students.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Planning to use interactive multimedia in the classroom.

Imagine that you are teaching in a co-educational school and have an upper primary or junior secondary class of 25 to 30 mixed ability students. The students have been trained to use a Macintosh computer and are capable of switching it on, and using a mouse. The table provided lists 5 themes from the "Animal Pathfinders" program. Listed in the columns, adjacent to the topics, are various forms of class organisation and teaching methods which could be used when teaching with "Animal Pathfinders". The final column contains the names of the submenus of the program. Each menu in this column may contain activities and materials that directly relates to the theme you choose.

Use the information provided in the support material and reflect upon the introduction you had to the program. Select one topic from the list and then select appropriate strategies for teaching this topic to the class described. Record your choices on the table as shown in the example or, if space is insufficient, use the blank table provided. Used lines to link class organisation, teaching methods and the menus in the final column. Consider carefully all the options and include all that you would use. Also include any additional strategies that you would use that are not in the list. A description of the teaching methods listed is provided in a separate table so that we all understand what they are.
PLANNING TABLE.

An example showing a sequence of three lessons is provided.

Planning table

<table>
<thead>
<tr>
<th>Topic</th>
<th>Class organisation</th>
<th>Teaching method</th>
<th>Matching menu from the program</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bee Dances</td>
<td>whole class</td>
<td>lecture/explanation</td>
<td>overviews</td>
</tr>
<tr>
<td>Protective</td>
<td>small groups</td>
<td>video presentation</td>
<td>database</td>
</tr>
<tr>
<td>Colouration</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Turtle Mystery</td>
<td>in pairs</td>
<td>class discussion</td>
<td>activities</td>
</tr>
<tr>
<td>Beaver Pond</td>
<td>individual use</td>
<td>small group discussion</td>
<td>resources</td>
</tr>
<tr>
<td>Animal Migration</td>
<td></td>
<td>problem solving</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>guided discovery</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>production of a multimedia report</td>
<td></td>
</tr>
</tbody>
</table>

Additional methods:
DESCRIPTIONS OF THE TEACHING METHODS LISTED IN THE PLANNING TABLE.

<table>
<thead>
<tr>
<th>Teaching method</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>whole class lecture/ demonstration.</td>
<td>the teacher presents the information to the whole class in a deductive way that is illustrated by teacher selected examples. Also the teacher may demonstrate how to perform a specific task.</td>
</tr>
<tr>
<td>whole class guided discovery.</td>
<td>the lesson is presented by the teacher in an inductive way, using a questioning strategy that elicits students' responses to the teacher selected stimuli. Students discover the learning objectives for themselves and help direct the course of the lesson.</td>
</tr>
<tr>
<td>small group cooperative learning.</td>
<td>students work in cooperative learning groups of three or four.</td>
</tr>
<tr>
<td>paired or individual hands on activity.</td>
<td>students work in pairs or individually on tasks that involve manipulation of equipment.</td>
</tr>
<tr>
<td>independent research.</td>
<td>students work in pairs or individually on their own research.</td>
</tr>
</tbody>
</table>
Consider the following statements about the teacher support material you have just used and indicate on the scale your rating of these statements by placing a number from 1 to 5 in the response box next to each statement.


<table>
<thead>
<tr>
<th></th>
<th>The sections are in a logical order.</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>I could quickly find the information required.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>The information was presented in a non-sequential manner.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>The way in which the information was presented encouraged me to follow my natural curiosity.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>The information was presented in a way that matched my normal learning style.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>The information presented helped me to understand more about the way children can use &quot;Animal Pathfinders&quot;.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>I find this form of teacher support to be useful.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>I find this form of teacher support to be boring.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>I prefer to use this form of teacher support.</td>
<td></td>
</tr>
</tbody>
</table>

Circle the support material that you used  
HyperCard  
Booklet
Appendix 3

Descriptive statistics from the questionnaire responses
### Appendix 3 Descriptive Statistics

#### $X_1: Q6$

<table>
<thead>
<tr>
<th>Mean</th>
<th>Std Dev</th>
<th>Std Error</th>
<th>Variance</th>
<th>Coef Var</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.413</td>
<td>.858</td>
<td>.127</td>
<td>.737</td>
<td>35.57</td>
<td>46</td>
</tr>
</tbody>
</table>


#### $X_2: Q7$

<table>
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<tr>
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<th>Std Error</th>
<th>Variance</th>
<th>Coef Var</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.87</td>
<td>1.108</td>
<td>.163</td>
<td>1.227</td>
<td>38.603</td>
<td>46</td>
</tr>
</tbody>
</table>


#### $X_3: Q8$

<table>
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<tr>
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<th>Std Error</th>
<th>Variance</th>
<th>Coef Var</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.717</td>
<td>.688</td>
<td>.102</td>
<td>.474</td>
<td>40.085</td>
<td>46</td>
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</table>


#### $X_4: Q9$

<table>
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<th>Std Error</th>
<th>Variance</th>
<th>Coef Var</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.283</td>
<td>.861</td>
<td>.127</td>
<td>.741</td>
<td>37.701</td>
<td>46</td>
</tr>
</tbody>
</table>


#### $X_5: Q10$

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<th>Std Error</th>
<th>Variance</th>
<th>Coef Var</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.957</td>
<td>1.154</td>
<td>.17</td>
<td>1.331</td>
<td>39.028</td>
<td>46</td>
</tr>
</tbody>
</table>


#### $X_6: Q11$

<table>
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<th>Std Error</th>
<th>Variance</th>
<th>Coef Var</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.283</td>
<td>.834</td>
<td>.123</td>
<td>.696</td>
<td>36.552</td>
<td>46</td>
</tr>
</tbody>
</table>


A3
### Appendix 3 Descriptive Statistics

#### X7: Q12

<table>
<thead>
<tr>
<th>Mean:</th>
<th>Std. Dev.:</th>
<th>Std. Error:</th>
<th>Variance:</th>
<th>Coef. Var.:</th>
<th>Count:</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.478</td>
<td>.888</td>
<td>.131</td>
<td>.788</td>
<td>25.528</td>
<td>46</td>
</tr>
</tbody>
</table>

<table>
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<th>Minimum:</th>
<th>Maximum:</th>
<th>Range:</th>
<th>Sum:</th>
<th>Sum of Sqr:</th>
<th># Missing:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
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<td>4</td>
<td>160</td>
<td>592</td>
<td>0</td>
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#### X8: Q13

<table>
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<th>Std. Error:</th>
<th>Variance:</th>
<th>Coef. Var.:</th>
<th>Count:</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.717</td>
<td>.958</td>
<td>.141</td>
<td>.918</td>
<td>35.266</td>
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<table>
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<th># Missing:</th>
</tr>
</thead>
<tbody>
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#### X9: Q14

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<th>Variance:</th>
<th>Coef. Var.:</th>
<th>Count:</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.674</td>
<td>.896</td>
<td>.132</td>
<td>.802</td>
<td>33.501</td>
<td>46</td>
</tr>
</tbody>
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<table>
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<th>Maximum:</th>
<th>Range:</th>
<th>Sum:</th>
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<th># Missing:</th>
</tr>
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<tbody>
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<td>1</td>
<td>5</td>
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<td>0</td>
</tr>
</tbody>
</table>

#### X10: Q15

<table>
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<tr>
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<th>Std. Error:</th>
<th>Variance:</th>
<th>Coef. Var.:</th>
<th>Count:</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.913</td>
<td>1.575</td>
<td>.232</td>
<td>2.481</td>
<td>54.073</td>
<td>46</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
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<th>Maximum:</th>
<th>Range:</th>
<th>Sum:</th>
<th>Sum of Sqr:</th>
<th># Missing:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>5</td>
<td>4</td>
<td>134</td>
<td>502</td>
<td>0</td>
</tr>
</tbody>
</table>

#### X11: Q16

<table>
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<th>Std. Dev.:</th>
<th>Std. Error:</th>
<th>Variance:</th>
<th>Coef. Var.:</th>
<th>Count:</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.043</td>
<td>.729</td>
<td>.107</td>
<td>.531</td>
<td>35.673</td>
<td>46</td>
</tr>
</tbody>
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<th>Sum:</th>
<th>Sum of Sqr:</th>
<th># Missing:</th>
</tr>
</thead>
<tbody>
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<td>1</td>
<td>4</td>
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</table>

#### X12: Q17

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<th>Variance:</th>
<th>Coef. Var.:</th>
<th>Count:</th>
</tr>
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<td>2.326</td>
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<td>.758</td>
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<th>Sum:</th>
<th>Sum of Sqr:</th>
<th># Missing:</th>
</tr>
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<td>4</td>
<td>3</td>
<td>107</td>
<td>283</td>
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</tr>
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</table>
### Appendix 3 Descriptive Statistics

<table>
<thead>
<tr>
<th>Variable</th>
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<th>Std. Dev.</th>
<th>Std. Error</th>
<th>Variance</th>
<th>Coef. Var.</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
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<td>.732</td>
<td>.108</td>
<td>.536</td>
<td>43.727</td>
<td>46</td>
</tr>
<tr>
<td></td>
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<td>3</td>
<td>77</td>
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<td>0</td>
</tr>
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<td>X14:019</td>
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<td>9.57</td>
<td>.141</td>
<td>9.16</td>
<td>33.352</td>
<td>46</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>5</td>
<td>4</td>
<td>132</td>
<td>420</td>
<td>0</td>
</tr>
<tr>
<td>X15:020</td>
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</tr>
<tr>
<td>X16:021</td>
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<tr>
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<td>99</td>
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</tr>
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<td>X17:022</td>
<td>1.935</td>
<td>.25</td>
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<tr>
<td></td>
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</tr>
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<td>57.648</td>
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<tr>
<td></td>
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<td>4</td>
<td>81</td>
<td>189</td>
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</tr>
</tbody>
</table>
### Appendix 3 Descriptive Statistics

#### X_{19}: Q24

<table>
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<tr>
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</tr>
</tbody>
</table>

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
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<td>1</td>
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<td>337</td>
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</tr>
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</table>

#### X_{20}: Q25

<table>
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<th>Variance</th>
<th>Coef Var.</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.435</td>
<td>.834</td>
<td>.123</td>
<td>.696</td>
<td>58.131</td>
<td>46</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Minimum</th>
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<th>Sum</th>
<th>Sum of Sqr.</th>
<th>* Missing</th>
</tr>
</thead>
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#### X_{21}: Q26

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<th>Count</th>
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<td>.122</td>
<td>.688</td>
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<th>Sum</th>
<th>Sum of Sqr.</th>
<th>* Missing</th>
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</thead>
<tbody>
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<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.5</td>
<td>.983</td>
<td>.145</td>
<td>.967</td>
<td>28.091</td>
<td>46</td>
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<table>
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<tr>
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<th>Sum</th>
<th>Sum of Sqr.</th>
<th>* Missing</th>
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</thead>
<tbody>
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#### X_{23}: Q28

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<th>Count</th>
</tr>
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<td>1.299</td>
<td>.192</td>
<td>1.687</td>
<td>42.676</td>
<td>46</td>
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</table>

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<th>Sum</th>
<th>Sum of Sqr.</th>
<th>* Missing</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>5</td>
<td>4</td>
<td>140</td>
<td>502</td>
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</tr>
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#### X_{24}: Q29

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<th>Std Error</th>
<th>Variance</th>
<th>Coef Var.</th>
<th>Count</th>
</tr>
</thead>
<tbody>
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<td>.878</td>
<td>.13</td>
<td>.771</td>
<td>26.067</td>
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<table>
<thead>
<tr>
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<th>Maximum</th>
<th>Range</th>
<th>Sum</th>
<th>Sum of Sqr.</th>
<th>* Missing</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>5</td>
<td>4</td>
<td>155</td>
<td>557</td>
<td>0</td>
</tr>
</tbody>
</table>
### Appendix 3 Descriptive Statistics

#### X 25: Q30

<table>
<thead>
<tr>
<th>Mean</th>
<th>Std Dev.</th>
<th>Std. Error</th>
<th>Variance</th>
<th>Coef. Var.</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.587</td>
<td>.956</td>
<td>.141</td>
<td>1.914</td>
<td>26.66</td>
<td>46</td>
</tr>
</tbody>
</table>

Minimum: 1, Maximum: 5, Range: 4, Sum: 165, Sum of Sqr: 633, Missing: 0

#### X 26: Q31

<table>
<thead>
<tr>
<th>Mean</th>
<th>Std Dev.</th>
<th>Std. Error</th>
<th>Variance</th>
<th>Coef. Var.</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.87</td>
<td>1.408</td>
<td>.208</td>
<td>1.983</td>
<td>49.068</td>
<td>46</td>
</tr>
</tbody>
</table>

Minimum: 1, Maximum: 5, Range: 4, Sum: 132, Sum of Sqr: 468, Missing: 0

#### X 27: Q32

<table>
<thead>
<tr>
<th>Mean</th>
<th>Std Dev.</th>
<th>Std. Error</th>
<th>Variance</th>
<th>Coef. Var.</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.63</td>
<td>.951</td>
<td>.14</td>
<td>1.905</td>
<td>36.162</td>
<td>46</td>
</tr>
</tbody>
</table>

Minimum: 1, Maximum: 5, Range: 4, Sum: 121, Sum of Sqr: 359, Missing: 0

#### X 28: Q33

<table>
<thead>
<tr>
<th>Mean</th>
<th>Std Dev.</th>
<th>Std. Error</th>
<th>Variance</th>
<th>Coef. Var.</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.196</td>
<td>1.088</td>
<td>.16</td>
<td>1.183</td>
<td>34.037</td>
<td>46</td>
</tr>
</tbody>
</table>

Minimum: 1, Maximum: 5, Range: 4, Sum: 147, Sum of Sqr: 523, Missing: 0

#### X 29: Q34

<table>
<thead>
<tr>
<th>Mean</th>
<th>Std Dev.</th>
<th>Std. Error</th>
<th>Variance</th>
<th>Coef. Var.</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.435</td>
<td>1.688</td>
<td>.101</td>
<td>1.473</td>
<td>15.515</td>
<td>46</td>
</tr>
</tbody>
</table>

Minimum: 2, Maximum: 5, Range: 3, Sum: 204, Sum of Sqr: 926, Missing: 0

#### X 30: Q35

<table>
<thead>
<tr>
<th>Mean</th>
<th>Std Dev.</th>
<th>Std. Error</th>
<th>Variance</th>
<th>Coef. Var.</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.978</td>
<td>1.649</td>
<td>.096</td>
<td>1.422</td>
<td>32.828</td>
<td>46</td>
</tr>
</tbody>
</table>

Minimum: 1, Maximum: 3, Range: 2, Sum: 91, Sum of Sqr: 199, Missing: 0
### Appendix 3 Descriptive Statistics

#### X31: Q36

<table>
<thead>
<tr>
<th>Mean:</th>
<th>Std Dev:</th>
<th>Std Error:</th>
<th>Variance:</th>
<th>Coef Var.:</th>
<th>Count:</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.435</td>
<td>.72</td>
<td>.106</td>
<td>.518</td>
<td>16.227</td>
<td>46</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Minimum:</th>
<th>Maximum:</th>
<th>Range:</th>
<th>Sum:</th>
<th>Sum of Sqr:</th>
<th>Missing</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>5</td>
<td>4</td>
<td>204</td>
<td>928</td>
<td>0</td>
</tr>
</tbody>
</table>

#### X32: Q37

<table>
<thead>
<tr>
<th>Mean:</th>
<th>Std Dev:</th>
<th>Std Error:</th>
<th>Variance:</th>
<th>Coef Var.:</th>
<th>Count:</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.848</td>
<td>.918</td>
<td>.135</td>
<td>.843</td>
<td>23.861</td>
<td>46</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Minimum:</th>
<th>Maximum:</th>
<th>Range:</th>
<th>Sum:</th>
<th>Sum of Sqr:</th>
<th>Missing</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>5</td>
<td>4</td>
<td>177</td>
<td>719</td>
<td>0</td>
</tr>
</tbody>
</table>

#### X33: Q38

<table>
<thead>
<tr>
<th>Mean:</th>
<th>Std Dev:</th>
<th>Std Error:</th>
<th>Variance:</th>
<th>Coef Var.:</th>
<th>Count:</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.065</td>
<td>.68</td>
<td>.106</td>
<td>.462</td>
<td>16.227</td>
<td>46</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Minimum:</th>
<th>Maximum:</th>
<th>Range:</th>
<th>Sum:</th>
<th>Sum of Sqr:</th>
<th>Missing</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>5</td>
<td>3</td>
<td>187</td>
<td>781</td>
<td>0</td>
</tr>
</tbody>
</table>

#### X34: Q39

<table>
<thead>
<tr>
<th>Mean:</th>
<th>Std Dev:</th>
<th>Std Error:</th>
<th>Variance:</th>
<th>Coef Var.:</th>
<th>Count:</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.804</td>
<td>.885</td>
<td>.106</td>
<td>.783</td>
<td>31.555</td>
<td>46</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Minimum:</th>
<th>Maximum:</th>
<th>Range:</th>
<th>Sum:</th>
<th>Sum of Sqr:</th>
<th>Missing</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4</td>
<td>3</td>
<td>129</td>
<td>397</td>
<td>0</td>
</tr>
</tbody>
</table>

#### X35: Q40

<table>
<thead>
<tr>
<th>Mean:</th>
<th>Std Dev:</th>
<th>Std Error:</th>
<th>Variance:</th>
<th>Coef Var.:</th>
<th>Count:</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.739</td>
<td>.743</td>
<td>.106</td>
<td>.553</td>
<td>19.882</td>
<td>46</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Minimum:</th>
<th>Maximum:</th>
<th>Range:</th>
<th>Sum:</th>
<th>Sum of Sqr:</th>
<th>Missing</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>5</td>
<td>3</td>
<td>172</td>
<td>668</td>
<td>0</td>
</tr>
</tbody>
</table>

#### X36: Q41

<table>
<thead>
<tr>
<th>Mean:</th>
<th>Std Dev:</th>
<th>Std Error:</th>
<th>Variance:</th>
<th>Coef Var.:</th>
<th>Count:</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.652</td>
<td>.849</td>
<td>.125</td>
<td>.721</td>
<td>23.246</td>
<td>46</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Minimum:</th>
<th>Maximum:</th>
<th>Range:</th>
<th>Sum:</th>
<th>Sum of Sqr:</th>
<th>Missing</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>5</td>
<td>3</td>
<td>168</td>
<td>646</td>
<td>0</td>
</tr>
</tbody>
</table>
### Appendix 3 Descriptive Statistics

#### X37: Q42

<table>
<thead>
<tr>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Std. Error</th>
<th>Coef. Var.</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.283</td>
<td>1.026</td>
<td>.151</td>
<td>1.052</td>
<td>46</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Minimum:</th>
<th>Maximum:</th>
<th>Range:</th>
<th>Sum:</th>
<th>Sum of Sqr:</th>
<th>Missing:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>5</td>
<td>4</td>
<td>151</td>
<td>543</td>
<td>0</td>
</tr>
</tbody>
</table>

#### X38: Q43

<table>
<thead>
<tr>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Std. Error</th>
<th>Coef. Var.</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.478</td>
<td>.752</td>
<td>.111</td>
<td>.566</td>
<td>46</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Minimum:</th>
<th>Maximum:</th>
<th>Range:</th>
<th>Sum:</th>
<th>Sum of Sqr:</th>
<th>Missing:</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>5</td>
<td>3</td>
<td>160</td>
<td>582</td>
<td>0</td>
</tr>
</tbody>
</table>

#### X39: Q44

<table>
<thead>
<tr>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Std. Error</th>
<th>Coef. Var.</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.783</td>
<td>.696</td>
<td>.103</td>
<td>.485</td>
<td>46</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Minimum:</th>
<th>Maximum:</th>
<th>Range:</th>
<th>Sum:</th>
<th>Sum of Sqr:</th>
<th>Missing:</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>5</td>
<td>3</td>
<td>174</td>
<td>680</td>
<td>0</td>
</tr>
</tbody>
</table>

#### X40: Q45

<table>
<thead>
<tr>
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<th>Std. Dev.</th>
<th>Std. Error</th>
<th>Coef. Var.</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.804</td>
<td>.749</td>
<td>.11</td>
<td>.561</td>
<td>46</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Minimum:</th>
<th>Maximum:</th>
<th>Range:</th>
<th>Sum:</th>
<th>Sum of Sqr:</th>
<th>Missing:</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>5</td>
<td>3</td>
<td>175</td>
<td>691</td>
<td>0</td>
</tr>
</tbody>
</table>

#### X41: Q46

<table>
<thead>
<tr>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Std. Error</th>
<th>Coef. Var.</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.913</td>
<td>.839</td>
<td>124</td>
<td>.703</td>
<td>46</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Minimum:</th>
<th>Maximum:</th>
<th>Range:</th>
<th>Sum:</th>
<th>Sum of Sqr:</th>
<th>Missing:</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>5</td>
<td>3</td>
<td>180</td>
<td>736</td>
<td>0</td>
</tr>
</tbody>
</table>

#### X42: Q47

<table>
<thead>
<tr>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Std. Error</th>
<th>Coef. Var.</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.935</td>
<td>.929</td>
<td>.137</td>
<td>.862</td>
<td>46</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Minimum:</th>
<th>Maximum:</th>
<th>Range:</th>
<th>Sum:</th>
<th>Sum of Sqr:</th>
<th>Missing:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4</td>
<td>3</td>
<td>89</td>
<td>211</td>
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</tr>
</tbody>
</table>
### Appendix 3 Descriptive Statistics

#### X43 :Q48

<table>
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<tr>
<th></th>
<th>Mean</th>
<th>Std Dev</th>
<th>Std Error</th>
<th>Variance</th>
<th>Coef. Var.</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2.739</td>
<td>1.163</td>
<td>1.171</td>
<td>1.353</td>
<td>42.46</td>
<td>46</td>
</tr>
</tbody>
</table>


#### X44 :Q49

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Std Dev</th>
<th>Std Error</th>
<th>Variance</th>
<th>Coef. Var.</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2.304</td>
<td>0.963</td>
<td>0.928</td>
<td>0.928</td>
<td>41.794</td>
<td>46</td>
</tr>
</tbody>
</table>


#### X45 :Q50

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Std Dev</th>
<th>Std Error</th>
<th>Variance</th>
<th>Coef. Var.</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2.739</td>
<td>1.063</td>
<td>1.015</td>
<td>1.13</td>
<td>38.816</td>
<td>46</td>
</tr>
</tbody>
</table>

**Minimum: 1, Maximum: 5, Range: 4, Sum: 126, Sum of Sqr: 396, *Missing: 0**

#### X46 :Q51

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Std Dev</th>
<th>Std Error</th>
<th>Variance</th>
<th>Coef. Var.</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1.543</td>
<td>0.78</td>
<td>0.609</td>
<td>0.609</td>
<td>50.568</td>
<td>46</td>
</tr>
</tbody>
</table>

**Minimum: 1, Maximum: 4, Range: 3, Sum: 71, Sum of Sqr: 137, *Missing: 0**

#### X47 :Q52

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Std Dev</th>
<th>Std Error</th>
<th>Variance</th>
<th>Coef. Var.</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2.196</td>
<td>1.34</td>
<td>1.38</td>
<td>1.372</td>
<td>42.529</td>
<td>46</td>
</tr>
</tbody>
</table>

**Minimum: 1, Maximum: 3, Range: 2, Sum: 101, Sum of Sqr: 261, *Missing: 0**

#### X48 :Q53

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Std Dev</th>
<th>Std Error</th>
<th>Variance</th>
<th>Coef. Var.</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2.913</td>
<td>0.89</td>
<td>0.89</td>
<td>0.792</td>
<td>30.556</td>
<td>46</td>
</tr>
</tbody>
</table>

### Appendix 3 Descriptive Statistics

#### X49: Q54

<table>
<thead>
<tr>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Std. Error</th>
<th>Variance</th>
<th>Coef. Var.</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.674</td>
<td>0.896</td>
<td>0.132</td>
<td>0.802</td>
<td>33.501</td>
<td>46</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Minimum:</th>
<th>Maximum:</th>
<th>Range:</th>
<th>Sum:</th>
<th>Sum of Sqr:</th>
<th>Missing:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>5</td>
<td>4</td>
<td>123</td>
<td>365</td>
<td>0</td>
</tr>
</tbody>
</table>

#### X50: Q55

<table>
<thead>
<tr>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Std. Error</th>
<th>Variance</th>
<th>Coef. Var.</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.022</td>
<td>0.906</td>
<td>0.134</td>
<td>0.822</td>
<td>44.838</td>
<td>46</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Minimum:</th>
<th>Maximum:</th>
<th>Range:</th>
<th>Sum:</th>
<th>Sum of Sqr:</th>
<th>Missing:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4</td>
<td>3</td>
<td>93</td>
<td>225</td>
<td>0</td>
</tr>
</tbody>
</table>

#### X51: Q56

<table>
<thead>
<tr>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Std. Error</th>
<th>Variance</th>
<th>Coef. Var.</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.652</td>
<td>0.795</td>
<td>0.117</td>
<td>0.632</td>
<td>48.113</td>
<td>46</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Minimum:</th>
<th>Maximum:</th>
<th>Range:</th>
<th>Sum:</th>
<th>Sum of Sqr:</th>
<th>Missing:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4</td>
<td>3</td>
<td>76</td>
<td>154</td>
<td>0</td>
</tr>
</tbody>
</table>

#### X52: Q57

<table>
<thead>
<tr>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Std. Error</th>
<th>Variance</th>
<th>Coef. Var.</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.783</td>
<td>0.892</td>
<td>0.132</td>
<td>0.796</td>
<td>50.054</td>
<td>46</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Minimum:</th>
<th>Maximum:</th>
<th>Range:</th>
<th>Sum:</th>
<th>Sum of Sqr:</th>
<th>Missing:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>5</td>
<td>4</td>
<td>82</td>
<td>182</td>
<td>0</td>
</tr>
</tbody>
</table>

#### X53: Q58

<table>
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<tr>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Std. Error</th>
<th>Variance</th>
<th>Coef. Var.</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.478</td>
<td>0.96</td>
<td>0.142</td>
<td>0.922</td>
<td>38.74</td>
<td>46</td>
</tr>
</tbody>
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Appendix 4

The support booklet
APPENDIX 4: BOOKLET SUPPORT

ANIMAL PATHFINDERS

INTRODUCTORY BOOKLET
## Contents

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<td>Overview information</td>
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<td>Activities information</td>
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<td>Video editor</td>
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<td>Videodisc controller</td>
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<td>Lesson Plans</td>
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<td>Further information</td>
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<td>Worksheets</td>
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**Introduction:**

This handbook provides you with the minimum information needed to successfully use the "Animal Pathfinders" program. You will be using this booklet away from the computer because I wish to find out which sections of this manual assist you when you don’t have access to the computer. The instructions concerning clicking of icons refer to the computer program that you have just used.

---

**Equipment**

Before you can use the "Animal Pathfinders" you require a computer, video disc player, colour video monitor, hard disc drive. Diagrams of the equipment are shown below:

---

**Getting Started**

These instructions will help you to start up the program when you are with the computer.

* switch on the computer, TV and video.
* insert the video disc with side A up.
* double click the icon on the computer screen labelled “Animal Pathfinders”.
* when asked if you want to use the videodisc player click on "YES"
* you now choose **program introduction or main menu**
* the program will now start.
* the first time you use the program start with **program introduction** as it gives you an overview of the program.
The Main Menu

There are 4 main sub-menus. When using the computer, use the mouse to point to the icon that matches the sub-menu you require. Then click on the icons chosen to find out more information about this sub-menu. The diagram following shows the icons that match these sub-menus

![Icons]

Overviews  Database  Activities  Resources

Overview

Overviews are short, narrative video sequences that will help you get started. These are on side A of the videodisc. Fifteen short films introduce the topics explored in the program.

The hour long Nova film, "The Mystery of Animal Migration", portrays the migrational patterns of seven different animals.

The sub-menu contains 4 topics to explore:
* How to use Interactive Nova.
* About Migration.
* Video explorations.
* Film: "The Mystery of Animal Pathfinders".

Database

The database, on Side A, consists of approximately 600 cards on animals, habitats and behaviours, each with a related slide or motion video clip lasting 20 seconds. It also includes the following theme tours:

* Why animals migrate.
* Protective colouration.
* Courting.
* Human Threats to Animals.
* Pond Food Web.
* Metamorphosis

Theme tours use slides, video and text to provide a basic understanding of concepts and issues associated with the themes listed above.
Activities

This sub-menu contains three interactive studies that are located on side B of the video disc. The studies are:

• Bee Dances.
• Turtle Mystery.

The "Bee Dances" activity allows you to learn about how bees communicate and then use this information in a simulation activity.

The "Turtle Mystery" is a multi-media adventure which allows you to learn about the human threats to turtles. It is more demanding than the "Bee Dances".

Resources

Six different aids are found on Side A of the videodisc.

* Help * Navigator * Report Maker
* Video Editor * References * Videodisc Controller

These aids are described in the following section.

Help

On screen help is provided through the help button which is:

a question mark ?

It is located in the lower right hand corner of most screens.

When you use the computer program you can click this button and a list of help topics will be displayed on the screen. If you click on the name of a topic, the help information about that topic will be displayed.
The navigator is a diagram of the entire program, which you can use to get around the program quickly. You can select this diagram at any time by clicking the button that looks like the one following:

It is found in the lower right-hand corner of most cards.

The navigator diagram displays the location you were just in by highlighting its name. To move to a new location just click the name of the new location on the navigator chart which looks like the one below.

The navigator screen shows the current location as shown below

<table>
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<td></td>
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<td>Freshwater</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Forest</td>
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For example, if you clicked the name "birds" you would go to that section of the program.

Video Editor

The video editor can be used to put together a sequence of video clips from Side A.

To create your video sequence when you use the program:

* switch all equipment on as outlined in "Getting Started" (page 1).
* click on the "Video Editor" button.
* click on the words "Create a New Video"
* then follow the on screen directions in the order presented.
References

This section contains the following:
* a glossary - you can click on key words and this action will take you to the glossary.
* an atlas with map titles relating to the program. Just click on the title required and the map requested is displayed on the screen.
* a bibliography of related films, videos and books as well as resources used for this program.
* photo credits.
* production credits.

Report Maker

Report maker is a tool for making multimedia reports. You can put together a sequence of database cards as well as cards that you write yourself. You may choose slides or video clips from Side A to accompany the cards. Sample reports are provided as examples and are accessible from the Report Maker sub-menu by clicking on the name of the report required.

Creating a Report with the program

* switch all equipment on as outlined in "Getting Started" (page 1).
* click on the words "Create a New Report" from the Report Maker menu.
* enter a title for your report.
* then follow the directions in the order that they are presented on the screen.

To add a slide or video clip:

* click the appropriate icon (a slide or TV icon).
* follow the directions in the order that they are presented on the screen.

Videodisc controller

This feature allows you to use the videodisc player independently from the rest of interactive Nova. On-screen control buttons appear at the bottom of cards and look like a normal video buttons. Clicking on the buttons makes the video disc behave like a normal video with fast forward, play, stop, pause and re-wind options.
Beaver Pond

Objectives:
* define terms habitat and niche, worksheets.
* explain how a beaver pond is created.
* describe the life cycle of a beaver pond.
* name at least three animals that live in a beaver pond habitat and describe their niches.

Strategies:
* duplicate appropriate
* set up equipment so the whole class can watch the program.
* use the school building as a model of a habitat e.g. roles of the people who "live" there, rooms they "live" in and relationships between them.
* show Beaver Pond Video Exploration.
* pass out student worksheets and have students answer level 1 questions. level 2 and 3 questions can be used for discussion or follow up.

Follow up:

* whole class:
Go to the Beaver Pond Habitat of the Database and click through the three cards that describe the beaver pond. You could guide the students through the cards by asking questions relating to the data.

* small groups:
After this introduction students could work in small groups, in pairs, or individually with the database.
Animal Migration

Objectives:
* define migration.
* explain the various factors that influence animal migration.
* name several internal and external triggers of animal migration.
* understand that migration is an adaptive strategy that evolved over time

Strategies:
* duplicate worksheet.
* set up equipment as for lesson 1.
* stimulus questions: What happens to birds and insects in winter? Where do they go? How do they get there?
* show the overview about animal migration to the class.
* pass out the student worksheet and discuss the first 2 questions.
* show the The Tour of Animal Migration. Students can fill in their answers to the worksheets as they watch the theme tour which is a set of cards that are accompanied by on screen visuals.
* the worksheets could then be discussed and marked.

Follow up:
* students work in small groups, individually, or in pairs with the Theme Tour or the database from the previous lesson to seek out additional information to answer questions such as:

Name three animals that migrate in search of food (Canada goose, free tail bat, ladybird beetle)
Why do green turtles and Pacific salmon migrate long distances? (to breed in an area that is free of predators).
Why techniques and technologies assist scientists to study migrating animals? (tagging, catching them enroute, putting transmitters on them, tracking by radar).
Protective Coloration

Objectives:

* understand the concept of evolutionary adaptation.

* identify protective colouration as an adaptation.

* describe two forms of protective colouration in animals.

* give examples of protective colouration in animals.

Strategies:

* ask the following question: "Why do you think different animals have different colours?"

  Can you explain why some animals are brightly coloured and others are not?"

  Can you explain why some animals copy the colours of other animals?

* some students could use a Theme Tour (see database) to find the answers while others use the library.

* students then report their findings which could later be verified using the information contained in the theme tour.

Follow up:

* students use the student worksheet provided.

* students work in groups, in pairs, or individually to prepare a chart of an Australian Animal that uses protective colouration.

Examples could come from specific habitats such as a desert, a freshwater pond or rock platform.
Turtle Mystery

Objectives:

* name 8 environmental issues that threaten the world’s sea turtles
* describe the behaviour and biology of sea turtles
* think critically about environmental issues and their impact on animals.

Strategies:

Students use the Turtle Mystery Activity in small groups, in pairs or individually to learn about the impact of environmental issues on sea turtles.

* duplicate student worksheets.
* general discussion of human threats to animals before beginning the activity.
* students work individually or individually, or in 2’s or 3’s.

Follow up:

* students write and publish a class newspaper article about why sea turtles are in danger of extinction.
* have students collect newspaper articles about human threats to animals.
* students present a multimedia report about the sea turtles. For further information see the “Resources” section of the “Animal Pathfinders” program.
Bee Dances

Objectives:

* understand that bees communicate through dances and sounds.

* recall that bees use the position of the sun to navigate to a food source

* interpret video of bee dances to find nectar and pollen.

Strategies:

* duplicate worksheets.

* presentation of the Honey Bee segment of the film, “The Mystery of the Animal Pathfinder” (on Side C of the laser disc)

* class presentation or before the bee dance activity or this can be done as a whole class or in small groups.

* the bee dance activities can then be presented to students working individually, as pairs, in small groups, as a whole class. This involves the reading of cards presented on the screen, watching of video clips, and looking at animations and simulations.

* After the bee dance activity, students can play the “You be the Bee” game as shown on the student worksheet. One student plays the part of the bee and imitates the dance that a bee would make in order to indicate where to find the nectar. Students then indicate the direction and distance on the worksheet.

Follow up:

* students may research the life and work of Karl Frisch, the scientist who broke the code of the bee dances.

* use the report maker function to make a multimedia report about the bee dances. This could be demonstrated the first time, then students could build on your demonstration. An example is provided in the report maker section of “Animal Pathfinders”.

INFORMATION:

BEAVER POND

Terms

*Habitat:* a place where a species lives. Each habitat contains food and shelter for all species that live there. It has its unique set of physical properties, such as quantity and quality of water, soil, available sunlight, and climate.

*Niche:* the ecological role a species plays within a habitat. It is related to other species in the habitat.

Students often confuse the terms habitat and niche. Different species can often occupy the same habitat but not the same niche e.g. if different species compete for the same food and shelter, one would usually be more successful and other would be forced out.

Although two species do not occupy the same niche within a habitat, different species often occupy similar niches in different habitats. A visit to a rock pool at low tide can be used to illustrate these concepts.

ANIMAL MIGRATION

Terms

*Migration:* the periodic, directional movement of animals from one region to another. Migrations may occur daily, monthly, annually or as once-in-a-lifetime events.

All migratory animals have the ability to orient themselves using external cues.

Animals migrate in order to survive. Richer food sources, safer breeding grounds or better weather may be the immediate benefits of migration e.g. the green turtle migrate long distances in order to find appropriate breeding spots. Animal migration is often a critical part of an animal’s life cycle and is most likely influenced by both instinct and learning.
PROTECTIVE COLORATION

Terms

Protective coloration is an evolutionary adaptation. Most organisms have evolved coloration slowly, over generations, by natural selection. Certain animal colourations and patterns have evolved because those members with those colour patterns and body types survive longer and produce more offspring than individuals without these traits.

Note:
The ideas are more important than the terms.

Two types of protective coloration exist: crypsis and aposematism.

Crypsis describes two forms of protective coloration. One form allows the animal to temporarily blend into its background, such as when a flounder temporarily assumes the colour and appearance of the ocean floor. The second one is one in which the animal’s permanent colour or shape allows it to blend into the environment; a familiar example is the “stick insect”.

Aposematism is the opposite of crypsis. The animal’s colour, instead of camouflaging the animal, draws attention to it. Aposematic animals are either poisonous or mimic the colouring of other animals that are poisonous or bitter to eat, a familiar example is the ladybird beetle.

TURTLE MYSTERY

Background:
Students begin their adventure in the chief editor’s office, where they are given the story assignment. A note is left asking students to gather information on the diminishing loggerhead turtle population and to keep a list of threats. As they explore students must find books, files, video tapes and a plane ticket to Florida. When all 8 threats have been found,

The Activity:
Students are playing the role of investigative journalists. The turtle Mystery provides exposure to environmental issues while teaching about the behaviour and biology of sea turtles. Along the way they gather items necessary for their investigation and collect data for their story. When students discover a threat to the turtle population, they must do something to protect the turtles. They will then be shown a short documentary describing the menace. The threat will then be automatically added to their threat list.

INFORMATION: Turtles may soon be extinct species. There are 6 types of sea turtles whose numbers are being reduced by shrimpers. Environmentalists argue that about 300 species of land and sea turtles should be given special care. Turtles live as long as 100 years. This helps the species to survive, by allowing a long time during which reproduction can occur. Human destruction of natural habitats has made turtles vulnerable. Turtles’ territories and behaviour often compel them to cross roads, so that they are often crushed by cars. As habitats are destroyed, it becomes difficult for adult turtles to find another mate. Turtles lay few eggs and fewer adults are now laying fewer eggs. Many hatchlings do not
survive to reproduce. Also turtles are eaten in many countries and their shells are used to make fashion accessories.

**BEE DANCES**

**Background:**
Students learn how honey bees use visual and auditory signs to communicate the location of nectar sources to other bees.

Once they learn the meaning of the bee dances, students play a computer-generated game in which they watch a bee dance and then try to find the nectar source.

**Further Information:**
Communication plays an important part in the animal world. An animal learns whether another animal is friend of foe by certain signals. Opposite sexes of a species are brought together to mate by signals. Animals stake their territorial boundaries by signals. Common signals of animal communication are sounds, visual signals, and chemical secretions e.g. when a cat arches its back, it communicates hostility.

**BEE DANCES:**
Female scout bees perform two types of dances - a **round dance** or **waggle dance**.

**Round dance:** performed if the nectar is within 30 metres of the hive. The female scout performs this dance by turning in circles, alternating directions from left to right. The flower scent and nectar she brings back to the hive also helps to worker bees to locate the nectar source.

**Waggle dance:** performed if the nectar is beyond 30 metres from the hive. The scout performs this dance by running a short distance in a straight line and wagging her abdomen from side to side. Then she returns in a semicircle to her starting point. She repeats the straight run and comes back in a semicircle on the opposite side. The number of waggles in each communication run communicates the distance to the source, while the direction of the straight line indicates the exact location of the nectar in relation to the sun’s position. Bees have a built-in internal clock which allows them to adjust for changes in the sun’s position over time. The straight line of the scout’s dance takes into account these changes.
Student Worksheet: Beaver Pond.

Name of Habitat: .............................................................

**Level 1:**

1. Name the animals that are predators in this habitat.
2. Name the animals that are prey in this habitat.
3. Name the animals that migrate in this habitat.
4. Name the animals that do not migrate in this habitat.
5. What are the producers in this habitat? What are the consumers? What are the decomposers?

**Level 2:**

1. Why do some animals migrate? Give two examples from this habitat.
2. Why are the animals that do not migrate able to survive for the whole year in this habitat?
3. Describe the physical characteristics of the habitat - the climate, soil water and landforms.

**Level 3:**

1. Discuss the seasonal changes that occur in this habitat. What adaptations do the animals have that help them to survive the changes in seasons?
2. Draw a diagram that illustrates a food web that occurs in this habitat.
### Student Worksheet: Why Animals Migrate.

Complete the table as you gather information from the Theme Tour (see the Database sub-menu) on Why Animals Migrate.

<table>
<thead>
<tr>
<th>Animal</th>
<th>Reason for migrating</th>
<th>Migration pattern</th>
</tr>
</thead>
<tbody>
<tr>
<td>honey bee</td>
<td>to find food</td>
<td>migrates every day</td>
</tr>
<tr>
<td>bison</td>
<td></td>
<td></td>
</tr>
<tr>
<td>free tail bat</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Canada goose</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ladybird beetle</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pacific salmon</td>
<td></td>
<td></td>
</tr>
<tr>
<td>green turtle</td>
<td></td>
<td></td>
</tr>
<tr>
<td>zebra</td>
<td></td>
<td></td>
</tr>
<tr>
<td>elk</td>
<td></td>
<td></td>
</tr>
<tr>
<td>trumpet swan</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**Student Worksheet: Protective Coloration**

Match the animals with their protective coloration. You can gather most of this information from the Theme Tour.

<table>
<thead>
<tr>
<th>Animal</th>
<th>Protective coloration</th>
</tr>
</thead>
<tbody>
<tr>
<td>coral snake</td>
<td></td>
</tr>
<tr>
<td>flounder</td>
<td></td>
</tr>
<tr>
<td>deer</td>
<td></td>
</tr>
<tr>
<td>ladybird beetle</td>
<td></td>
</tr>
<tr>
<td>monarch butterfly</td>
<td></td>
</tr>
<tr>
<td>viceroy butterfly</td>
<td></td>
</tr>
<tr>
<td>&quot;stick insect&quot;</td>
<td>camouflage</td>
</tr>
<tr>
<td>four-eyed butterfly fish</td>
<td></td>
</tr>
<tr>
<td>fiddler crab</td>
<td></td>
</tr>
<tr>
<td>panthea moth</td>
<td></td>
</tr>
</tbody>
</table>
Student Worksheet: Turtle Mystery Reporter's Notebook

What are the threats to loggerhead turtles? Jot down the answers to this mystery as you do the Turtle Mystery Activity. There are 8 threats to find.

<table>
<thead>
<tr>
<th>Threat</th>
<th>How does this affect the turtles?</th>
<th>What can be done to prevent this problem?</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Student Worksheet: Bee Dances - You Be the Bee!

You can use the worksheet following to play the "You Be the Bee" activity with a partner.

First cut out the bee, sun and food icons.

Then have one person put the sun somewhere on the diagram and play the part of the bee by moving the bee icon to simulate a bee dance. The other person can then place the food icon where he or she thinks it should go on the diagram in relation to the sun and the hive.

Take turns at playing the bee.
Appendix 5

The HyperCard support
The Main Menu

There are 4 main sub-menus as shown. When you are connected to the main program, you can click on these icons to activate these sub-menus. The icons below are connected to cards that provide additional information and you may click on them to view these cards.

- Overviews
- Database
- Activities
- Resources

Getting started with the program

- Switch on the computer, TV and video
- Insert the video disc with side A up.
- Double click the icon labelled "home".
- When asked if you want to use the videodisc player click on "YES."
- You now choose program introduction or main menu
- The first time you use the program start with program introduction as it gives you an overview of the program.

Equipment required to use the program

A computer, video disc player, colour video monitor, hard disc drive are needed.
Overview information

Overviews are short narrative video sequences that will help you get started. These are on side A of the videodisc. Fifteen short films introduce the topics explored in the program.

The hour long Nova film, "The Mystery of Animal Migration", portrays the migrational patterns of seven different animals.

The sub-menu contains 4 topics to explore:
- How to use Interactive Nova.
- About Migration.
- Video explorations.
- Film: The Mystery of Animal Pathfinders.

Database information

The Database, on side A, consists of approximately 600 cards on animals, habitats and behaviours, each with a related slide or motion video clip lasting 20 seconds. It also includes theme tours. Theme tours combine slides, video and text to make a presentation about one of the following themes:
- Why animals migrate.
- Protective colouration.
- Courting.
- Human Threats to Animals.
- Pond Food Web.
- Metamorphosis.

Activities information

There are interactive studies on side B of the videodisc. Two are:
- Bee Dances.
- Turtle Mystery.

Bee Dances allows you to learn how bees dance to communicate the location of nectar sources. This information is then used in a simulation activity.

Turtle Mystery is a multimedia adventure game which allows you to learn about the human threats to turtles. It is more demanding than Bee Dances.
Introduction to "Animal Pathfinders".

### Resources menu

Six different aids are found on Side A of the videodisc. Click on the names below to find out more information about these aids.

- Help
- Navigator
- Report maker
- Video Editor
- References
- Videodisc Controller

### Help information

When you use the main program, on screen help is provided through the help button which is:

- a question mark

This is located in the lower right hand corner of most screens.

When you click on this button, a list of help topics is displayed. To receive help you just click on the required topic. The screen will then display the information you require.

### Navigator information

The navigator is a diagram of the entire program which you can use to get around the program quickly. To see the diagram click on the icon that looks like this in the lower right-hand corner of most cards.

When you click on the navigator icon, the location you were in will be highlighted. To move to a new location just click the name of the new location on the navigator. The next card shows what part of the navigator screen looks like.
A5 Introduction to *Animal Pathfinders*.

### Navigator screen shows the current location

<table>
<thead>
<tr>
<th>Overviews</th>
<th>Mammals</th>
<th>Birds</th>
<th>Reptiles/Amphibians</th>
<th>Fish</th>
</tr>
</thead>
<tbody>
<tr>
<td>- How to Use</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- About Migration</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Video Explorations</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Film The Mystery</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Database</td>
<td>Insects</td>
<td>Other Animals</td>
<td>Marine</td>
<td></td>
</tr>
<tr>
<td>- Animals</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Habitats</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Behaviours</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Report maker information

The report maker is a tool for making multimedia reports. You can put together a sequence of prepared database cards as well as cards that you write yourself. You may choose slides or video clips from Side A to accompany the cards. Sample reports are provided as examples and are accessible from the Report Maker sub-menu.

Click the words below to find out more information about how to create a report.

To create a report:

### Video editor

Video editor can be used to put together a sequence of video clips from Side A.

To create your video sequence with the main program:

* switch on all equipment as outlined in “Getting Started”

* Click on the words "Video Editor" on the screen.

* Click on the words "Create a New Video"

* follow the directions in the order presented on the screen directions.
**Information: Beaver Pond**

**TERMS**

- **Habitat**: A place where a species lives. Each habitat contains food and shelter for all species that live there. It has its unique set of physical properties, such as quantity and quality of water, soil, available sunlight, and climate.

- **Niche**: The ecological role a species plays within a habitat. It is related to other species in the habitat.

Students often confuse the terms habitat and niche. Different species can often occupy the same habitat but not the same niche. If different species compete for the same food and shelter, one would usually be more successful and the other would be forced out. Although two species do not occupy the same niche within a habitat, different species often occupy.

**Information: Animal Migration**

**TERMS**

- **Migration**: The periodic, directional movement of animals from one region to another. Migrations may occur daily, monthly, annually or as once-in-a-lifetime events.

- All migratory animals have the ability to orient themselves using external cues.

Animals migrate in order to survive. Richer food sources, safer breeding grounds or better weather may be the immediate benefits of migration. For example, the green turtle migrates long distances in order to find appropriate breeding spots. Animal migration is often a critical part of an animal’s life cycle and is most likely influenced by both instinct and learning.

**Information: Protective Coloration**

**TERMS**

- **Protective coloration**: An evolutionary adaptation. Most organisms have evolved coloration slowly, over generations, by natural selection. Certain animal colorations and patterns have evolved because those members with those color patterns and body types survive longer and produce more offspring than individuals without those traits.

Note: the ideas are more important than the terms. Two types of protective coloration exist: crypsis and aposematism. Crypsis describes two forms of protective coloration. One form allows the animal to temporarily blend into its background, such as when a flounder temporarily assumes the color and appearance of the ocean floor. The second one is one.
Information: Turtle Mystery

**BACKGROUND:**
Students begin their adventure in the chief editor's office, where they are given the story assignment. A note is left asking students to gather information on the diminishing loggerhead turtle population and to keep a list of threats. As they explore, students must find books, files, video tapes, and a plane ticket to Florida. 8 threats have to be found.

**THE ACTIVITY:**
Students are playing the role of investigative journalists. The Turtle Mystery provides exposure to environmental issues while teaching about the behavior and biology of sea turtles. Along the way, they gather items necessary for their investigation and collect data for their story. When students discover a threat to the turtle population, they...

Information: Bee Dances

**BACKGROUND:**
Students learn how honey bees use visual and auditory signs to communicate the location of nectar sources to other bees.

Once they learn the meaning of the bee dances, students play a computer-generated game in which they watch a bee dance and then try to find the nectar source.

**FURTHER INFORMATION:**
Communication plays an important part in the animal world. An animal learns whether another animal is friend or foe by certain signals. Opposite sexes of a species are brought together to mate by signals. Animals stake their territorial boundaries by signals. Common signals of animal communication are sounds, visual signals, and chemical...
Creating a report with the program

- switch on all equipment as outlined in "Getting Started"
- click on "Create a New Report" from the Report Maker sub-menu.
- enter a title for your report.
- follow the directions in the order that they are presented on the screen.

To add a slide or video clip:
- click on the appropriate icon (i.e. either a slide or TV).
- follow the directions in the order that they are presented on the screen.

References

This section of the program contains the following:
- a glossary - you can enter the glossary by clicking on terms that are presented on the screen.
- an atlas with map titles relating to the program. Just click on the title to see the required map displayed on the screen.
- a bibliography of related films, videos and books as well as resources used for this program. This can be searched by topic.
- photo credits.
- production credits.

Videodisc controller

This allows you to use the videodisc player independently from the rest of interactive Nova. The control panel appears at the bottom of each card that is associated with a video clip. Displayed on the screen are buttons for fast forward, rewind, pause, play and stop. You can click on these buttons and the video disc will respond just like a video player.
### Lessons: Turtle Mystery

**Objectives:**
- Name 8 environmental issues that threaten the world’s sea turtles.
- Describe the behaviour and biology of sea turtles.
- Think critically about environmental issues and their impact on animals.

**Strategies:**
- Students use the Turtle Mystery Activity in small groups, in pairs or individually to learn about the impact of environmental issues on sea turtles.
- Duplicate student worksheets.
- General discussion of human threats to animals before.

### Lessons: Bee Dances

**Objectives:**
- Understand that bees communicate through dances and sounds.
- Recall that bees navigate to a food source using the position of the sun.
- Interpret video of bee dances to find nectar and pollen sources.

**Strategies:**
- Duplicate worksheets.
- Presentation of the Honey Bee segment of the film, “The Mystery of Animal Pathfinder” (on side C of the video disc) before the bee dance activity. This can be done as a whole class presentation or in small groups.
**Lessons: Beaver Pond**

**Objectives:**
- define terms habitat and niche
- explain how a beaver pond is created.
- describe the life cycle of a beaver pond.
- name at least three animals that live in a beaver pond habitat and describe their niches.

**Strategies:**
- duplicate appropriate worksheets.
- set up equipment so whole class can watch the program.
- use the school building as a model of a habitat eg. roles of the people who "live" there, rooms they "live" in and relationships between them.
- show Beaver Pond Video

---

**Lessons: Animal Migration**

**Objectives:**
- define migration.
- explain the various factors that influence animal migration.
- name several internal and external triggers of animal migration.
- understand that migration is an adaptive strategy that evolved over time.

**Strategies:**
- duplicate worksheet.
- set up equipment as for lesson 1.
- stimulus questions:
  - What happens to birds and insects in winter?
  - Where do they go?
  - How do they get there?
  - show the overview about animal migration to the class.

---

**Lessons: Protective Coloration**

**Objectives:**
- understand the concept of evolutionary adaption.
- identify protective colouration as an evolutionary adaptation.
- describe two forms of protective colouration in animals.
- give examples of protective colouration in animals.

**Strategies:**
- ask the following questions:
  - Why do you think different animals have different colours?
  - Can you explain why some animals are brightly coloured and others are not?
  - Can you explain why some animals copy the colours of other animals?
Student Worksheet 1: Beaver Pond.
Name of Habitat: .........................................................
Level 1:
1. Name the animals that are predators in this habitat.
2. Name the animals that are prey in this habitat.
3. Name the animals that migrate in this habitat.
4. Name the animals that do not migrate in this habitat.
5. What are the producers in this habitat? What are the consumers?
   What are the decomposers?
Level 2:
1. Why do some animals migrate? Give two examples from this habitat.
2. Why are the animals that do not migrate able to survive for the whole year in this habitat?

Student Worksheet 2: Why Animals Migrate.
Complete the table as you gather information from the Theme Tour on Why Animals Migrate.

<table>
<thead>
<tr>
<th>Animal</th>
<th>Reason for migrating</th>
<th>Migration pattern</th>
</tr>
</thead>
<tbody>
<tr>
<td>honey bee</td>
<td>to find food</td>
<td>migrates every day</td>
</tr>
<tr>
<td>bison</td>
<td></td>
<td></td>
</tr>
<tr>
<td>freetail bat</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Canada goose</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ladybird beetle</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pacific salmon</td>
<td></td>
<td></td>
</tr>
<tr>
<td>green turtle</td>
<td></td>
<td></td>
</tr>
<tr>
<td>zebra</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Student Worksheet 3: Protective Coloration
Match the animals with their protective coloration. You can gather most of this information from the Theme Tour.

<table>
<thead>
<tr>
<th>Animal</th>
<th>Protective coloration</th>
</tr>
</thead>
<tbody>
<tr>
<td>coral snake</td>
<td></td>
</tr>
<tr>
<td>flounder</td>
<td></td>
</tr>
<tr>
<td>deer</td>
<td></td>
</tr>
<tr>
<td>ladybird beetle</td>
<td>camouflage</td>
</tr>
<tr>
<td>monarch butterfly</td>
<td></td>
</tr>
<tr>
<td>viceroy butterfly</td>
<td></td>
</tr>
<tr>
<td>&quot;stink insect&quot;</td>
<td>camouflage</td>
</tr>
<tr>
<td>four-eyed butterfly fish</td>
<td></td>
</tr>
<tr>
<td>fiddler crab</td>
<td></td>
</tr>
</tbody>
</table>
Student Worksheet 5: Bee Dances - You Be the Bee!

You can use the worksheet shown on the previous card to play the "You Be the Bee" activity with a partner.

First cut out the bee, sun and food icons.

Then have one person put the sun somewhere on the diagram and play the part of the bee by moving the bee icon to simulate a bee dance. The other person can then place the food icon where he or she thinks it should go on the diagram in relation to the sun and the hive.

Take turns at playing the bee.
Appendix 6

Data from observations
### APPENDIX 6: DATA GATHERED WHILE SUBJECTS WERE PLANNING LESSONS THAT USED THE INTERACTIVE MULTIMEDIA PROGRAM.

<table>
<thead>
<tr>
<th>Subject Support Number</th>
<th>Observations and comments made during the planning task</th>
<th>De-briefing comments</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>217</strong> B-booklet</td>
<td>The navigation map was referred to at the start but it was not used again. Started at the main menu and then read through the lesson plans in sequence. Skipped to the resources sub-menu and commented on the report maker option &quot;This was an interesting option.&quot; Went back to the lessons and then read through further information and the lesson plans. Decided that &quot;Bee Dances&quot; was the most suitable topic. Remembered that she had to select the activities sub-menu in order to teach this topic. Closed booklet and then selected the teaching strategies.</td>
<td>I would like to have been able to interact with the program and test and review the strategies. The lesson plans were the most useful although I could see the value of the resources sub-menu if I had access to the whole package. I found the lesson strategies somewhat limiting but perhaps this is a limit of the package. Time taken= 11 minutes</td>
</tr>
<tr>
<td><strong>216</strong> B-computer</td>
<td>Referred to the map at the end of the session. Did not use it at all with the booklet. Went straight to the lesson plans. When using the lesson plans said &quot;The lesson plans are most useful to me because they present practical issues.&quot; Looked at the lesson plans and then the information. At this stage decided to choose the &quot;Bee Dances&quot;. Then read through the rest of the booklet and returned to the resources before selecting teaching strategies.</td>
<td>If I hadn't been introduced to the screen and computer first, I would have found it difficult to become interested in the booklet. Probably I would have them not looked at the package. The contents could have been more detailed and this may have led you directly to what you wanted. The lesson plans are most useful to me because they discussed practical issues relating to the topic.&quot; It was a safety valve which I went back to because I felt comfortable. Time: 16 minutes.</td>
</tr>
</tbody>
</table>
9 | B | Referred to the map on three occasions: at the start, after choosing a topic and when selecting teaching strategies. Started at lesson plans. Wanted to know what a "theme tour" was. Found it but didn't recall the demonstration of the theme tour. Returned back to the information and the worksheets. Selected the "Beaver Pond" at this stage. Looked at the map and then glanced at but didn't read activities and resources sub-menu. Selected teaching strategies at this stage. Used the navigation map to "jog memory." Skimmed through most material.

The booklet made it boring and if I hadn't seen the package first I probably wouldn't have bothered looking at it if the booklet had been my first introduction.

Time = 7.5 minutes.

18 | B | Referred to the map at the start. Subject said "I remember that there is an activity on bees and I am going to look at this first." The subject flipped through the booklet to the lesson plan on "Animal Migration." Subject had difficulty in locating information required on the activity. Went to the main menu and read the sub-menus in sequence until the end (skipped sections in information and resources). Stopped and filled in the sheet. Chose "Animal Migration". Glanced back at the map once and at the lesson plans and worksheets again.

The main menu and lesson plans were useful but my use of this material suffered from not having the multimedia material at hand when I used the booklet.

I needed to refer back to the video.

Time taken = 13.5 minutes.
| 209 | B  | Referred to the map and then studied the contents first and then went to introduction, then in sequence to lesson plans. Then skimmed lesson plans scanning each lesson, followed by flicking back and forth as lesson were compared. Information and worksheets were then read through in sequence. At this stage was still uncertain about which topic to use. Referred back to the map. Went to resources and the database sub-menus to see how these related to the lesson plans. Decided on the “Beaver Pond.” | I would have liked to interact with the program to test and review strategies I proposed. The lesson plans were the most useful materials but I also used the activities section. Time taken= 14 minutes |
| 21  | B  | Opening statement "I am going to read the map and the main menu start and then flick through the booklet because to the lesson plans because I have a topic in mind, .. so I am just looking for a suitable lesson plans ." Skimmed through lesson plans, information and the worksheets. Then selected the "Turtle Mystery." Finally read through the activities sub-menu and finished by selecting of teaching strategies. Subject did not alter topic originally chosen. | After observing people with the hypercard stack I felt that it was easier to use than the booklet. The main menu was the place to start as it gave me direction and reminded me to explore the extent of the program. The equipment section was not needed. It was difficult to get to the planning stage at first as I found myself more interested in the capabilities of the program. This was due to the novelty of the program. I would have liked to have used a computer program that outlined the uses and possible outcomes of the system. Time taken = 12 minutes. |
| 9 | C | Initially read the navigation map and then put it down. Started at the lesson plans and read them in sequence. Did the same with the information and worksheets. Then went to the main menu as she wanted to find out more about the program. Chose her topic at this point and then referred back to the navigation map.

She then went back to the main menu and went to activities and resources sub-menus. Subject commented that she is a "text confident" person and likes to see instructions in printed text and likes to follow a structured sequence. Chose "Protective Coloration".

The lesson plans and worksheets are the most useful sections for me because they gave me ideas about what I do with children.

The video-computer link up was easy to use and would be a successful teaching tool.

I prefer to use printed text but I didn't have any trouble using the computer support materials. I liked the idea of using the buttons to go from one place to another.

Time taken= 15.5 minutes |
|---|---|---|
| 1 | C | Referred to the map and then started at the lesson plans and read them in sequence. Did the same with the information and worksheets. Choose her topic here and referred back to the map. Then went to the main menu and then on to the resources. She was particularly interested in the video editor and report maker sections. Went back to the main menu.

Later she went to the activities section. Chose "Beaver Pond"

The worksheets were the most useful sections as they helped me to choose the topic and gave me examples of what I do.

I found the equipment section was unnecessary.

I would have liked to have seen a video of a class using this equipment.

I found the computer support easy to use.

Time taken= 15.5 minutes |
Referred to the map and spent time thinking about where to start. Started at main menu and then went to lesson plans. Carefully read all lessons and then went to the worksheets and again read all sheets. Returned to lesson plans to check "Turtle Mystery" and "Beaver Pond" lessons. Was trying to decide between these two lessons. Went to information to check "Turtle Mystery" and "Protective Coloration". At this stage chose "Pond" topic. Then went to the main menu and explored the other menus. At this stage glanced back to the map to check that she had explored all options. Then she made her choices of teaching strategies. During this time she referred back to the lesson plan. Stated that she enjoyed exploring the main menu and was interested in exploring each section so that she could make maximum use of the program.

The lesson plans and the main menu were the most useful parts for me. I enjoyed using the hypercard stack and probably could have used the map more often but I found it fun to press the buttons and explore the options.

The equipment section was not needed if you have used the materials before.

Time taken = 17.5 minutes.
| 19 | C | Did not look at the map at the start. Started at lesson plans and skimmed through cards and then returned to the start to carefully read each lesson plan. She then had three possibilities in mind. Went to the information and worksheets and read through these. Moved back and forth between cards comparing. At this stage she glanced at the map commented "I suppose I should have started with this." She then had two topics in mind. To resolve this she went to information and read the information cards. At this stage she chose the "Turtle Mystery." Glanced back to the map to see where to go to next.

Went to main menu and explored each related section before making other decisions. As she made her choices of teaching strategies, she referred back to the relevant sections of the support material. | I felt nervous because I don't like computers. The lesson plans and worksheets were very useful but the report maker was the part that interested me the most.

The equipment section was not needed as I know this.

I found it difficult to decide which section of the program should be used (e.g., resources, activities, ...) and I would have liked to have time on my own to try more sections of the video disc.

Even though I hate computers, I could manage this program and would like to use it with a class.

Time taken = 18 minutes |
This subject had a particular topic in mind. Referred to the map and found the lesson plans. Started at lesson plans and read these cards. Then went to the main menu comment - "it gave me an overview of what was available." Referred to the map again and want to find out where the report maker was. Commented "The report maker interested me." Originally expected to be able to clicking a word and observing report making in progress but soon realised that she needed to be connected to the video disc player. Referred to the map again and paused - "thinking about where to go next".

The resources and database menus were searched thoroughly with cards being compared. Went back to the lesson plans, information and worksheets comment- "I only looked at the lessons and worksheets that interested me."

The topic chosen was "Animal Migration."

I have no particular preference about support. I would prefer to have a combination of booklet and computer support.

I found the resources and information to be of most use to me.

Time taken= 16 minutes.

| 16 | C | Started by referring to the map. Went to main menu and then went to the lesson plans-read the lessons then went back through them again. Did the same with the information and worksheets before deciding on the Beaver Pond lesson. Tended to go back to the main menu often as this was a navigation aid and continued exploring the other sections. Did not refer to the map again. The information as presented "eased" eased me into the task. A video presentation about teaching with IM would help. I feel that the hypercard system allowed me to follow my natural curiosity. I did not use the map because I like to follow my own curiosity. Time taken= 17.5 minutes.

| 30 | C | Started by referring to the map. Went to main menu and then went to the lesson plans-read the lessons then went back through them again. Did the same with the information and worksheets before deciding on the Beaver Pond lesson. Tended to go back to the main menu often as this was a navigation aid and continued exploring the other sections. Did not refer to the map again. The information as presented "eased" eased me into the task. A video presentation about teaching with IM would help. I feel that the hypercard system allowed me to follow my natural curiosity. I did not use the map because I like to follow my own curiosity. Time taken= 17.5 minutes. |
| 214 | C | Glance at the map at the start. When searching stopped to think at each sub-menu - reason given "in order to let the information 'sink in'". Started at lesson plans and just kept moving from card to card. Started to go back through the cards again but realised had seen them before. Stopped and looked at the main menu and said "I can see how all of the sections go together." Then went to worksheets and read each card. Went to information and again read all cards. Decided on "The Beaver Pond." Paused - said "was thinking about what to do next." Looked at the map again and then went to the Main Menu. At this stage could see where to go to next. Went to activities, database and resources. Then filled in the table. | I preferred the hypercard support and felt that the main menu and lesson plans were the most useful. I would feel more comfortable having a booklet as well as a computer as it is possible to get lost in the program. Time taken= 21 minutes |
| 10  | B | Glanced at the map at the start and commented that it may not be needed. Started at Introduction / Main menu. Read through each section of the booklet in the sequence but skipped two worksheets, and 3 topics in resources. Then went to the sheet and recorded the teaching strategies. Went back to lesson plans and information at this stage. Topic chosen was "Turtle Mystery" | The lesson plans were the most useful although I could see the value of the resources sub-menu if I had access to the whole package. I would like to have been able to interact with the whole program and review the strategies. Time taken= 21 minutes. |
| 26 | B | Referred to the map at the start and then read through lesson plans, information and worksheets. Decided that the "Turtle Mystery" was the most appropriate topic to use. Went to the other sections at the start of the booklet - realised that the activities section was needed for teaching this topic. Then began to fill in the teaching strategies on the table. Glanced at the map while selecting teaching strategies. | The contents could have been more detailed and this may have led you directly to what you wanted.

If I hadn't been introduced to the screen and computer first, I would have found it difficult to become interested in the booklet. You should have given me the booklet right at the start...but probably I would have them not looked at the package if the booklet had been my only introduction.

Time taken= 15 minutes. |
| --- | --- | --- | --- |
| 33 | B | Began by skimming through the introduction, and main menu sections. Carefully read overviews-remembered that the "Animal Migration" topic was presented in this section. Went to the lesson plans and skimmed through to "Animal Migration". Then compared all lessons by flipping back and forth. Skimmed through the information and worksheets. Referred back to the activities sub-menu and only glanced at the other sections. Decided that the "Turtle Mystery" was the topic he would use. Then began choosing teaching strategies. | I used the lesson plans most of all but I didn't need to use the information or worksheets at this stage. I would probably read them carefully if I was really going to teach this topic.

The booklet didn't present any problems for me.

Time Taken= 15 minutes. |
<p>| 18 | B | Read map and then studied the contents. Went through booklet in sequence to lesson plans. Then read lesson plans - read each lesson, then flicked back and forth between &quot;Bee Dances&quot; and the &quot;Animal Migration&quot; as lesson were compared. Information and worksheets about these lessons were then read through. At this stage was still uncertain about which topic to use. Went to resources, activities and the database to see how these related to the lesson plans. Decided on the &quot;Animal Migration&quot; and then filled in teaching strategies on the sheet. | I would have liked to work with the program. I think that the lesson plans, information and worksheets are needed. The booklet was easy to use but I would like to try the hypercard as well. Time taken = 13.5 minutes. |
| 7  | B | Referred to the map and then read the booklet in page sequence until lesson plans. Decided to use &quot;Turtle Mystery&quot;. Then read the further information and worksheets associated with this topic. After finishing completed the selection of teaching strategies. | The booklet contained enough information to get me started but no more than this. Was this done deliberately? The navigation map was the place to start as it gave me direction and allowed to fully understand the extent of the program. The equipment section was not needed. Time taken = 14.5 minutes |
| 22 | B | Read the navigation map at the start. Read the pages through in sequence-decision made about which topic to choose after reading all pages. Then returned to the main menu and the sub-menus of overviews, database, activities, resources. Chose &quot;Turtle Mystery&quot; because could use the activities options with this topic. | The main menu was used the most. It was the key to understanding all the dimensions of the program and to getting to other points. I feel that if I has used the computer instead of the booklet at all, I could have found all I needed on the screen. I see a multiplicity of teaching methods possible. Optimally, I believe that this material should be used with small groups or, ideally, in pairs; but larger groups should be used when providing context clarifying and global issues. It is very important that this material be used collaboratively with students and teachers as learning partners. Small schools with limited budgets will find it difficult to purchase such equipment. After observing a subject using the hypercard introduction, I am sure that I would have preferred it to the booklet but the booklet does provide a useful back up. Time taken= 13 minutes |
| 1    | C       | Read the navigation map and started at the main menu and explored the sections of this menu. When using the database commented that he would have liked to explore some slides from the laser disc. Read and compared the lesson plans before narrowing down to three options. Went to further information to to decide between three options. By the time he went to the worksheets, she had decided on &quot;The Beaver Pond.&quot; Paused to read the map. Then went back to the resources and the main menu to find out which sections of the program would apply. | Both the main menu and resources were important to me. The equipment and getting started sections were not needed. Another way that teachers could be in-serviced about this medium is through peer tutoring. Time taken= 15.5 minutes |
| 12   | C       | Carefully studied the navigation map. Started at main menu and went to lesson plans, scanned the lesson in order. Decided that &quot;Protective Coloration&quot; was appropriate Then went to the main menu to find the appropriate sub-menu. Fully explored the activities and resources sections as they related to the topic chosen. Then went to the information and worksheets and read through the cards. At this point filled in the table. | The introduction section was not useful but the lesson plans and main menu were. The brief navigation sheet helped me to navigate more rapidly. The stack support would quicker for me as I am an experienced computer user Time taken= 15 minutes |</p>
<table>
<thead>
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<tbody>
<tr>
<td>5</td>
<td>C</td>
<td>Started by studying the navigation map. Looked at lesson plans and carefully read lessons. Did the same for information and worksheets sections. Stated that was enjoyed exploring the main menu and was interested in exploring each sub-menu thoroughly. Referred back to the map to check that he had not missed any sections. Decided that the &quot;Protective Coloration&quot; was the most suitable topic. Then explored the sections he hadn't seen and completed the selection table. Occasionally paused and referred back to the navigation map.</td>
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<td></td>
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<td>I would liked to have been able to linked to the laser disc so that I could call up examples. Another alternative is to have a video tape with examples. Overall the lesson plans were the best part of the support material for me. Time taken= 15.5 minutes</td>
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<tr>
<td>8</td>
<td>C</td>
<td>Referred to the navigation map and then started at main menu and glanced between the button icons and the map to see what was available. Went to lesson plans where time was spent reading and comparing lessons. Looked at &quot;Protective Coloration&quot; in more detail and then went to the resources and activities sub-menus. Decided that the &quot;Protective coloration&quot; was the topic to use and then went the information and worksheet cards associated with this topic. Filled in the table</td>
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<td></td>
<td></td>
<td>I found the main menu useful but the best part was the lessons plans. By the time I had read the further information section I had decided upon a suitable topic. The resources and activities sections told what could be used from the program. Time taken= 17.5 minutes</td>
</tr>
<tr>
<td>16</td>
<td>C</td>
<td>Did not refer to the navigation at the start. Stated that he was interested in the &quot;Animal Migration&quot; topic. Started at the lesson plans then went to the main menu. Compared the map to the on-screen icons and went to the report maker in the resources sub-menu. Spent time comparing cards in the resources sub-menu. Lot of back and forward movement. &quot;trying to understand this section.&quot;. Returned to the main menu and went from card to card exploring each one in turn. Then filled in the teaching strategies sheet. Paused and went to lesson plan on the &quot;Animal Migration&quot; then went to information. Finished filling in the sheet. Glanced to the navigation map while filling in the sheet.</td>
</tr>
<tr>
<td>17</td>
<td>C</td>
<td>Referred to the map at the start then started at main menu. Went to the lesson plans-read the lessons then went back through them again. Did the same with the worksheets before deciding on the &quot;Beaver Pond&quot; lesson. Went back to the main menu, then went to overviews - database-activities and resources sub-menus. Explored all sections of the resources sub-menu, often returned to the main menu. At the end of the session returned to the lesson plans then went to the information section and finally back to the worksheets. Used this menu as a navigation aid in preference to the map provided. At this stage filled in the teaching strategies on the sheet. Once she paused and referred back to the resources sub-menu.</td>
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</tbody>
</table>
Appendix 7

Examples of lesson plans from the subjects given extra time
Lesson plans from subjects who received additional time with the interactive multimedia package.

Subject 1: Female undergraduate student

Aims:

For children to familiarise themselves with the laser disc, computer and mouse and overall multimedia package. To encourage participation and enthusiasm for learning with new technology.

Objectives:

By the end of the lesson the children will have:

- participated in explorations of the multimedia system;

- familiarised themselves with basic sequence of topics, functions of system and used the mouse competently;

- shown verbal understandings of the operating system.

Grouping:

- Whole class introduction and discussion.

- Small groups for actual participation.

- Whole class for review.
Sequence of Activities:

1. Have system set up and ready to go (overhead projector, laser disc, computer and mouse, and video screen).

2. Introduce children to each aspect of equipment and use correct terminology.

3. Start the disc running to and show some functions and brief overview of each topic.

4. Repeat this sequence with children in small groups, guiding themselves through and making relevant decisions. Offer assistance where necessary.

5. Allow children to explore the package for at least 10 minutes, at their own pace.

6. Rotate groups until all children have had a turn.

7. During course of a discussion, children will tell where they have reached, what they liked best/least, if they feel confident using equipment.

8. Review lesson and again name the pieces of equipment used and the skills the children have employed (mouse, typing, decision making, cooperating, gaining meaning).
Evaluation:

Did children enjoy activity?

Were they more confident at end of session?

Did they co-operate in group work?

Did you think children were capable of using it effectively or if many more sessions would be needed?

Recognise that there are a variety of environments at local and global levels

This package and its components deals with a number of differing and unique organisms. Each lives in a different environment, recognisable because of climate, terrain, food supply etc. Children will understand this and be able to infer that some organisms share the same or similar environments and others have differing ones. We all live in an environment be it natural or built, and globally, there are thousands of unique environments.

Recognise that needs, wants and interests of individuals and groups of people can result in competition for resources

Just as humans compete for resources, animals sharing the same environment must compete for resources, food, shelter... Children will ultimately understand how the environment copes with this in form of carnivores, survival of the fittest, many offspring, single offspring, scavengers... .
Skills

Perceive components of the environment using all their senses

Using this package will encourage children to use their sense of touch to use the keyboard, they can view the video and hear the narration that accompanies this. Will encourage listening skills if they take notes.

Investigate a variety of environments

The multimedia package allows the children to explore a number of differing environments and habitats at their own pace and to follow a specific topic of interest. The children can see on the video screen the recognisable characteristics of each environment and observe the variety of animals that co-habitate there. The text provides additional information on the actual environment and its characteristics.

Research appropriate sources of information on the environment

Children are able to see both an overview and specific details on the environment of the organism they are exploring. The teacher may wish to extend this type of learning by developing skills of research, using the multimedia package as a springboard to find specific interests and then getting the children to continue research at the library or at home. Children will be advised where to look for more information and then start to develop their own skills at locating, researching and collecting data.
Subject 2: Female undergraduate student

Lesson plan

Animals - their life cycles and activities: Where do humans fit in?

Objectives

• Students will understand how their own actions and those of others effect animal cycles. From the package we see the Monarch Butterfly is potentially in danger as its migration ground in Mexico is beginning to be logged. From this he children realise that destruction of natural habitat not only effects the natural flora and fauna but also those who migrate for specific purposes. Therefore, we are fostering a realisation and a concern for the potential impact we have on fauna and flora, and migration.

• Students will be able to organise, classify, analyse, and evaluate the information given on the Multi Media package as well as the other animals researched. The Multi Media package gave some information which was uninteresting whilst some of it was great. To find the information relevant to them the children must use their skills to sift through the information.

• Students will develop enthusiasm for investigating aspects of the environment which animals use for their activities and their life cycles. It is important for the children to develop positive attitudes towards the environment and the animals so that they realise the interrelationship between the two and find knowledge of their own on the environment through their own investigation.
Teaching strategies

• Lead up to the package by discussing and investigating animal life patterns of various species.

• Research migration - What animals migrate? Why?

• Go out into the school yard and record what animals are found, if they would migrate, and what their life cycle would be.

• Build an 'environmental corner' of our own at the school (a long term goal). After the garden has began to grow find out what animals are living there and observe what they use in the garden, i.e. eat decomposed materials etc.

• Use a role play of what it would be like if all of the plants and trees were taken from your local area.

• Take the class to a Museum of Natural History.

Subject 3: Female undergraduate student

I chose this resource because it may be controlled by one computer, yet shared with the whole class. All the children are able to do it as the instructions are clear and easy to follow. For the most part these programs are an interesting new way to learn about the environment which involves the children through activities. I also chose it because it is good to get the children to learn how to use new technology and to learn from the new technology.
The other reason I chose this resource is because it would be good to use with mildly physically handicapped children.

This resource would be effective with a fifth or sixth grade because many of the tables and charts will be too difficult for younger children to comprehend.

**Concepts**

The concepts that I found relating to this resource include changes in the environment—that is changes in animals in the environment; for example the life cycle of a butterfly. The concept of ecosystems, where animals live and what they eat, and the concept of populations in the environment and their behaviour patterns is also addressed.

**Theme**

The theme I would use when using this resource is "Behaviour patterns of animals".

**Objectives**

In using this resource I would hope that the children would investigate the migration and behaviour patterns of the monarch butterfly, and be able to describe it's life-cycle. The children's ability to measure, record, organise and analyse data from the environment will also be developed. My final objective is to develop enthusiasm for investigating the environment.
Teaching strategies

Some of the major teaching strategies I would implement in this unit are to let the children do hands on activities so as to promote self discovery. I will also do activities where the children have to collect, organise and analyse data for themselves. Finally the children would need some guide by demonstration when using the computer and collecting data.

Improving the program

This particular program on the monarch butterfly could be improved if it were made a little more exciting and adventurous for the children to do. Often as I was doing it, it became a little monotonous and I felt overwhelmed with information and facts. Perhaps the activities used to involve the children could be varied more as they were all involved in filling in tables.
Appendix 8

Examples of comments from the follow up interviews
Post-experiment comments

During theses interviews subjects were asked to comment upon their actions during the search process and to make any other comments about the observation process that they wished to make.

Subject 1: Male post-graduate.

I was constantly trying to investigate the HyperCard stack in a manner that was logical. I felt the need to do this so that the observer would be able to map my navigation through the stack. Possibly if there was an absence of concrete mapping then I would have jumped around a lot more without any clear motive other than randomly exploring the stack - something akin to flicking through the pages of a book.

I wasn't necessarily trying to make mistakes but if I had to re-navigate a particular segment of the stack. I felt that I was being less than efficient in my approach even though re-examination of stack cards would be a legitimate, logical thing to do.

Subject 2: Female post-graduate

I was participating in a relaxed state for the following reasons:

I was familiar with the Macintosh computer and the principles of operation of HyperCard.

The multimedia package was dealing with a content area in which I have a high degree of interest. It could also have direct application to my classroom experience, thus motivating me to explore it.
Having known the observer for a number of years professionally, there was little concern about being observed.

**Subject 3: Female undergraduate.**

The observation session provided the opportunity to explore the HyperCard support package. My initial investigations were concerned with examining the range of options. I was drawn further into the package following a particular piece of content that captured my interest (Camouflage). On reflection, this action seemed to have been connected to my thoughts as I travelled to the observation session. (They concerned primary science, light and colour). When this particular pathway failed to demonstrate all of the available options of the multimedia package, I selected a new content area which could do so.

Throughout the observation period, my impression is that my selections were quite easily observable. Since they were often accompanied by a commentary, I feel confident that the observer saw what was really happening.

The interview provided the opportunity to explain why particular choices were made on the HyperCard stack.
Subject 4: Male undergraduate

It is probably relevant initially to mention that I briefly played the Turtle Mystery during the free exploration before beginning the experiment/observation process so I have some idea of the nature of the software. As well, I had really enjoyed my interaction with the computer program so I felt a little let down when I realised I was to be observed using the booklet. My contact with the program on the computer had also given me a feel for the contents of the program and therefore tended to immediately shape the way in which I thought I would use the software in an actual lesson I feel this had some impact on the way I approached the booklet.

Initially I visited Main Menu/Overview and then Lesson Plans, but after this I tended to flick through the book from front to back getting a brief overview of what the rest of the booklet looked like. Then I went back to the sections that were of interest to me.

I feel that the observer may have captured most of what took place during my process with the book. I do not wish to devalue the 'mapping process' which I thought was very useful - its just that in its present form I feel the map is still a bit clinical. In my case it was only later in the discussion between subject/observer that my processes/intentions could be more fully explored.
Subject 5: Male post-graduate.

The process of navigation of the stack created a little concern to begin with, as the demands of the software was close to where I "was at" in respect to computers (ability with computers). I began to verbalise thoughts, initially to myself and then to the observer who was supportive but didn't supply feedback at this stage. At one stage I also attempted to create a diagram on the map of my path through the stack. This helped me to unravel the 'maze'.

During the session I found it difficult not to take a completely impartial role as I wanted to call upon the observer to assist. This was a frustrating aspect of the experience.
Appendix 9

Numerical data